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NATIONAL GEOGRAPHIC

The Rise of Mammals

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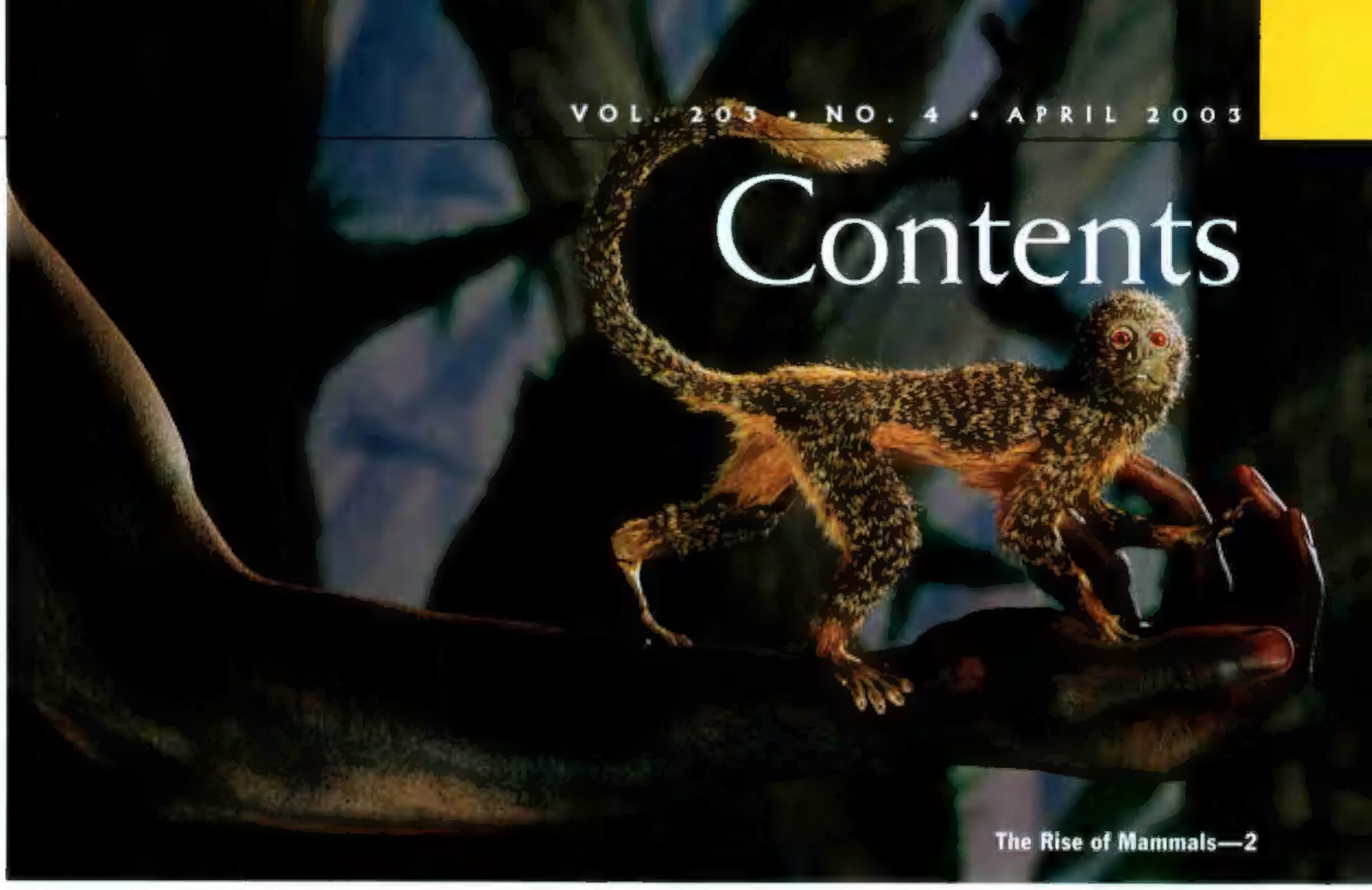

The Rise of Mammals—2

FEATURES

DEPARTMENTS

THE COVER

It's a girl! Seven months pregnant in the photo that opens the mammals story on page 2, model Julie Marques holds her newborn daughter, Amelia.
BY ROBERT CLARK

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From the Editor

HUGO VAN LAWICK

Why are the simplest gestures often the most profound? A young scientist reaches out to one of her subjects and, with a touch of hands, forever changes the relationship between the two species. But we now know to expect nothing less from Jane Goodall. Since our first cover story by this remarkable woman ran in 1965, the Society has supported her landmark studies of chimpanzees in Tanzania's Gombe National Park through numerous articles, films, and 26 research grants.

BILL ALLEN AND JANE GOODALL IN 1994; PHOTO BY MARISA DOMEYKO, NGS STAFF

As Jane reports on page 76, Gombe is now surrounded by barren hillsides, leaving the chimps' future uncertain. Yet she fights on, always optimistic, ready to hunker down with farmers, African presidents, even magazine editors (above) to drive home her point: Individuals can change the world—with the right touch.

Bill Allen

■ Watch my preview of the May issue on ***National Geographic Today*** on April 16 at 7 p.m. and again at 10 p.m. (ET and PT) on the National Geographic Channel.

Flonase is approved to treat more triggers than any of these allergy medicines.

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†Available over-the-counter.

‡"Allegra, Claritin, Zyrtec, Flonase, Nasonex, and Clarinex are among the leading prescription allergic rhinitis products."
Source: Scott-Levin's Source™ Prescription Audit (SPA) from Verispan; October 2001-September 2002.

Please see important information on the following page.

FLONASE®
(fluticasone propionate)
Nasal Spray, 50 mcg

BRIEF SUMMARY

For Intranasal Use Only. **SHAKE GENTLY BEFORE USE.**

The following is a brief summary only; see full prescribing information for complete product information.

CONTRAINDICATIONS

FLONASE Nasal Spray is contraindicated in patients with a hypersensitivity to any of its ingredients.

WARNINGS

The replacement of a systemic corticosteroid with a topical corticosteroid can be accompanied by signs of adrenal insufficiency, and in addition some patients may experience symptoms of withdrawal, e.g., joint and/or muscular pain, lassitude, and depression. Patients previously treated for prolonged periods with systemic corticosteroids and transferred to topical corticosteroids should be carefully monitored for acute adrenal insufficiency in response to stress. In those patients who have asthma or other clinical conditions requiring long-term systemic corticosteroid treatment, too rapid a decrease in systemic corticosteroids may cause a severe exacerbation of their symptoms.

The concomitant use of intranasal corticosteroids with other inhaled corticosteroids could increase the risk of signs or symptoms of hypercorticism and/or suppression of the hypothalamic-pituitary-adrenal (HPA) axis.

Persons who are using drugs that suppress the immune system are more susceptible to infections than healthy individuals. Chickenpox and measles, for example, can have a more serious or even fatal course in susceptible children or adults using corticosteroids. In children or adults who have not had these diseases or been properly immunized, particular care should be taken to avoid exposure. How the dose, route, and duration of corticosteroid administration affect the risk of developing a disseminated infection is not known. The contribution of the underlying disease and/or prior corticosteroid treatment to the risk is also not known. If exposed to chickenpox, prophylaxis with varicella zoster immune globulin (VZIG) may be indicated. If exposed to measles, prophylaxis with pooled intramuscular immunoglobulin (IG) may be indicated. (See the respective package inserts for complete VZIG and IG prescribing information.) If chickenpox develops, treatment with antiviral agents may be considered.

Avoid spraying in eyes.

PRECAUTIONS

General: Intranasal corticosteroids may cause a reduction in growth velocity when administered to pediatric patients (see PRECAUTIONS: Pediatric Use).

Rarely, immediate hypersensitivity reactions or contact dermatitis may occur after the administration of FLONASE Nasal Spray. Rare instances of wheezing, nasal septum perforation, cataracts, glaucoma, and increased intraocular pressure have been reported following the intranasal application of corticosteroids, including fluticasone propionate.

Use of excessive doses of corticosteroids may lead to signs or symptoms of hypercorticism and/or suppression of HPA function.

Although systemic effects have been minimal with recommended doses of FLONASE Nasal Spray, potential risk increases with larger doses. Therefore, larger than recommended doses of FLONASE Nasal Spray should be avoided.

When used at higher than recommended doses or in rare individuals at recommended doses, systemic corticosteroid effects such as hypercorticism and adrenal suppression may appear. If such changes occur, the dosage of FLONASE Nasal Spray should be discontinued slowly consistent with accepted procedures for discontinuing oral corticosteroid therapy.

In clinical studies with fluticasone propionate administered intranasally, the development of localized infections of the nose and pharynx with *Candida albicans* has occurred only rarely. When such an infection develops, it may require treatment with appropriate local therapy and discontinuation of treatment with FLONASE Nasal Spray. Patients using FLONASE Nasal Spray over several months or longer should be examined periodically for evidence of *Candida* infection or other signs of adverse effects on the nasal mucosa.

Intranasal corticosteroids should be used with caution, if at all, in patients with active or quiescent tuberculous infections of the respiratory tract; untreated local or systemic fungal or bacterial infections; systemic viral or parasitic infections; or ocular herpes simplex.

Because of the inhibitory effect of corticosteroids on wound healing, patients who have experienced recent nasal septal ulcers, nasal surgery, or nasal trauma should not use a nasal corticosteroid until healing has occurred.

Information for Patients: Patients being treated with FLONASE Nasal Spray should receive the following information and instructions. This information is intended to aid them in the safe and effective use of this medication. It is not a disclosure of all possible adverse or intended effects.

Patients should be warned to avoid exposure to chickenpox or measles and, if exposed, to consult their physician without delay.

Patients should use FLONASE Nasal Spray at regular intervals for optimal effect. Some patients (12 years of age and older) with seasonal allergic rhinitis may find as-needed use of 200 mcg once daily effective for symptom control (see Clinical Trials section of full prescribing information).

A decrease in nasal symptoms may occur as soon as 12 hours after starting therapy with FLONASE Nasal Spray. Results in several clinical trials indicate statistically significant improvement within the first day or two of treatment; however, the full benefit of FLONASE Nasal Spray may not be achieved until treatment has been administered for several days. The patient should not increase the prescribed dosage but should contact the physician if symptoms do not improve or if the condition worsens.

For the proper use of FLONASE Nasal Spray and to obtain maximum improvement, the patient should read and follow carefully the patient's instructions accompanying the product.

Drug Interactions: In a placebo-controlled, crossover study in 8 healthy volunteers, coadministration of a single dose of orally inhaled fluticasone propionate (1,000 mcg; 5 times the maximum daily intranasal dose) with multiple doses of ketoconazole (200 mg) to steady state resulted in increased mean fluticasone propionate concentrations, a reduction in plasma cortisol AUC, and no effect on urinary excretion of cortisol. This interaction may be due to an inhibition of cytochrome P450 3A4 by ketoconazole, which is also the route of metabolism of fluticasone propionate. No drug interaction studies have been conducted with FLONASE Nasal Spray; however, care should be exercised when fluticasone propionate is coadministered with long-term ketoconazole and other known cytochrome P450 3A4 inhibitors.

Carcinogenesis, Mutagenesis, Impairment of Fertility: Fluticasone propionate demonstrated no tumorigenic potential in mice at oral doses up to 1,000 mcg/kg (approximately 20 times the maximum recommended daily intranasal dose in adults and approximately 10 times the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 78 weeks or in rats at inhalation doses up to 57 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults and approximately equivalent to the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 104 weeks.

Fluticasone propionate did not induce gene mutation in prokaryotic or eukaryotic cells in vitro. No significant clastogenic effect was seen in cultured human peripheral lymphocytes in vitro or in the mouse micronucleus test.

No evidence of impairment of fertility was observed in reproductive studies conducted in male and female rats at subcutaneous doses up to 50 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis). Prostatic weight was significantly reduced at a subcutaneous dose of 50 mcg/kg.

Pregnancy: Teratogenic Effects: Pregnancy Category C. Subcutaneous studies in the mouse and rat at 45 and 100 mcg/kg, respectively (approximately equivalent to and 4 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis, respectively) revealed fetal toxicity characteristic of potent corticosteroid compounds, including embryonic growth retardation, omphalocele, cleft palate, and retarded cranial ossification.

In the rabbit, fetal weight reduction and cleft palate were observed at a subcutaneous dose of 4 mcg/kg (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis). However, no teratogenic effects were reported at oral doses up to 300 mcg/kg (approximately 25 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis) of fluticasone propionate to the rabbit. No fluticasone propionate was detected in the plasma in this study, consistent with the established low bioavailability following oral administration (see CLINICAL PHARMACOLOGY section of full prescribing information).

Fluticasone propionate crossed the placenta following oral administration of 100 mcg/kg to rats or 300 mcg/kg to rabbits (approximately 4 and 15 times, respectively, the maximum recommended daily intranasal dose in adults on a mcg/m² basis).

There are no adequate and well-controlled studies in pregnant women. Fluticasone propionate should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Experience with oral corticosteroids since their introduction in pharmacologic, as opposed to physiologic, doses suggests that rodents are more prone to teratogenic effects from corticosteroids than humans. In addition, because there is a natural increase in corticosteroid production during pregnancy, most women will require a lower exogenous corticosteroid dose and many will not need corticosteroid treatment during pregnancy.

Nursing Mothers: It is not known whether fluticasone propionate is excreted in human breast milk. However, other corticosteroids have been detected in human milk. Subcutaneous administration to lactating rats of 10 mcg/kg of tritiated fluticasone propionate (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis) resulted in measurable radioactivity in the milk. Since there are no data from controlled trials on the use of intranasal fluticasone propionate by nursing mothers, caution should be exercised when FLONASE Nasal Spray is administered to a nursing woman.

Pediatric Use: Five hundred (500) patients aged 4 to 11 years and 440 patients aged 12 to 17 years were studied in US clinical trials with fluticasone propionate nasal spray. The safety and effectiveness of FLONASE Nasal Spray in children below 4 years of age have not been established.

Controlled clinical studies have shown that intranasal corticosteroids may cause a reduction in growth velocity in pediatric patients. This effect has been observed in the absence of laboratory evidence of HPA axis suppression, suggesting that growth velocity is a more sensitive indicator of systemic corticosteroid exposure in pediatric patients than some commonly used tests of HPA axis function. The long-term effects of this reduction in growth velocity associated with intranasal corticosteroids, including the impact on final adult height, are unknown. The potential for "catch-up" growth following discontinuation of treatment with intranasal corticosteroids has not been adequately studied. The growth of pediatric patients receiving intranasal corticosteroids, including FLONASE Nasal Spray, should be monitored routinely (e.g., via stadiometry). The potential growth effects of prolonged treatment should be weighed against the clinical benefits obtained and the risks/benefits of treatment alternatives. To minimize the systemic effects of intranasal corticosteroids, including FLONASE Nasal Spray, each patient should be titrated to the lowest dose that effectively controls his/her symptoms.

Geriatric Use: A limited number of patients 65 years of age and older (n=129) or 75 years of age and older (n=11) have been treated with FLONASE Nasal Spray in US and non-US clinical trials. While the number of patients is too small to permit separate analysis of efficacy and safety, the adverse reactions reported in this population were similar to those reported by younger patients.

ADVERSE REACTIONS

In controlled US studies, more than 3,300 patients with seasonal allergic, perennial allergic, or perennial nonallergic rhinitis received treatment with intranasal fluticasone propionate. In general, adverse reactions in clinical studies have been primarily associated with irritation of the nasal mucous membranes, and the adverse reactions were reported with approximately the same frequency by patients treated with the vehicle itself. The complaints did not usually interfere with treatment. Less than 2% of patients in clinical trials discontinued because of adverse events; this rate was similar for vehicle placebo and active comparators.

Systemic corticosteroid side effects were not reported during controlled clinical studies up to 6 months' duration with FLONASE Nasal Spray. If recommended doses are exceeded, however, or if individuals are particularly sensitive or taking FLONASE Nasal Spray in conjunction with administration of other corticosteroids, symptoms of hypercorticism, e.g., Cushing syndrome, could occur.

The following incidence of common adverse reactions (>3%, where incidence in fluticasone propionate-treated subjects exceeded placebo) is based upon 7 controlled clinical trials in which 536 patients (57 girls and 108 boys aged 4 to 11 years, 137 female and 234 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 2 to 4 weeks and 2 controlled clinical trials in which 246 patients (119 female and 127 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 6 months. Also included in the table are adverse events from 2 studies in which 167 children (45 girls and 122 boys aged 4 to 11 years) were treated with FLONASE Nasal Spray 100 mcg once daily for 2 to 4 weeks.

Overall Adverse Experiences With >3% Incidence on Fluticasone Propionate in Controlled Clinical Trials With FLONASE Nasal Spray in Patients >4 Years With Seasonal or Perennial Allergic Rhinitis

Adverse Experience	Vehicle Placebo (n=758) %	FLONASE 100 mcg Once Daily (n=167) %	FLONASE 200 mcg Once Daily (n=782) %
Headache	14.6	6.6	16.1
Pharyngitis	7.2	6.0	7.8
Epistaxis	5.4	6.0	6.9
Nasal burning/ nasal irritation	2.6	2.4	3.2
Nausea/vomiting	2.0	4.8	2.6
Asthma symptoms	2.9	7.2	3.3
Cough	2.8	3.6	3.8

Other adverse events that occurred in ≤3% but ≥1% of patients and that were more common with fluticasone propionate (with uncertain relationship to treatment) included: blood in nasal mucus, runny nose, abdominal pain, diarrhea, fever, flu-like symptoms, aches and pains, dizziness, bronchitis.

Observed During Clinical Practice: In addition to adverse events reported from clinical trials, the following events have been identified during postapproval use of fluticasone propionate in clinical practice. Because they are reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events have been chosen for inclusion due to either their seriousness, frequency of reporting, or causal connection to fluticasone propionate or a combination of these factors.

General: Hypersensitivity reactions, including angioedema, skin rash, edema of the face and tongue, pruritus, urticaria, bronchospasm, wheezing, dyspnea, and anaphylaxis/anaphylactoid reactions, which in rare instances were severe.

Ear, Nose, and Throat: Alteration or loss of sense of taste and/or smell and, rarely, nasal septal perforation, nasal ulcer, sore throat, throat irritation and dryness, cough, hoarseness, and voice changes.

Eye: Dryness and irritation, conjunctivitis, blurred vision, glaucoma, increased intraocular pressure, and cataracts.

Cases of growth suppression have been reported for intranasal corticosteroids, including FLONASE (see PRECAUTIONS: Pediatric Use).

OVERDOSAGE

Chronic overdosage may result in signs/symptoms of hypercorticism (see PRECAUTIONS). Intranasal administration of 2 mg (10 times the recommended dose) of fluticasone propionate twice daily for 7 days to healthy human volunteers was well tolerated. Single oral doses up to 16 mg have been studied in human volunteers with no acute toxic effects reported. Repeat oral doses up to 80 mg daily for 10 days in volunteers and repeat oral doses up to 10 mg daily for 14 days in patients were well tolerated. Adverse reactions were of mild or moderate severity, and incidences were similar in active and placebo treatment groups. Acute overdosage with this dosage form is unlikely since 1 bottle of FLONASE Nasal Spray contains approximately 8 mg of fluticasone propionate.

The oral and subcutaneous median lethal doses in mice and rats were >1,000 mg/kg (>20,000 and >41,000 times, respectively, the maximum recommended daily intranasal dose in adults and >10,000 and >20,000 times, respectively, the maximum recommended daily intranasal dose in children on a mg/m² basis).

GlaxoSmithKline

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Research Triangle Park, NC 27709

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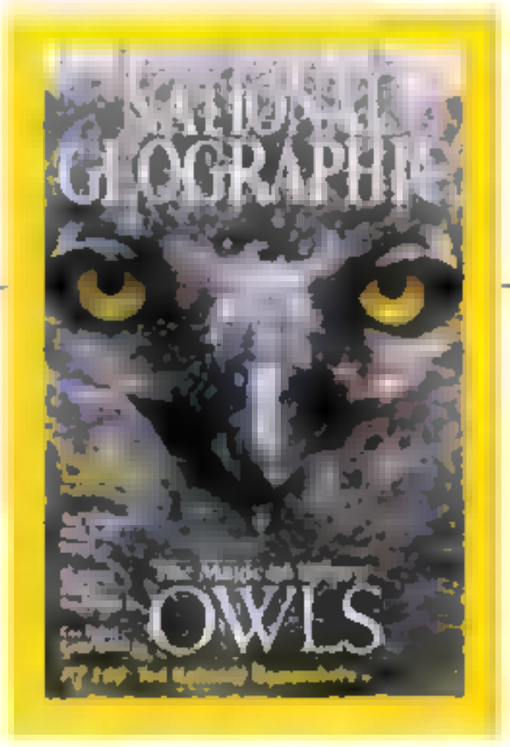

December 2002

While even the most popular stories bring at least a few letters from disappointed readers, some subjects provoke outright anger. In December readers blasted John Hare's team of Sahara explorers for their treatment of camels, two of which had to be abandoned and probably died. Equally irate letters came in response to the PT 109 *story, which resurrected plenty of anti-Kennedy sentiment.*

The Hawaiians

The founding premise of Paul Theroux's article seems to be that Hawaii was a peaceful paradise before Europeans showed up. Although it is unquestionable that native culture was suppressed, a very important part of the story was left out: Hawaiian culture prior to Captain James Cook was not peaceful but filled with warfare and near-constant power struggles of a most violent nature. Hawaiian society was also extremely stratified—it had what we would call today a caste system. Human sacrifice was practiced. I grew up in Hawaii and love the place, but the whole story should be told, not just the pretty parts.

DAVID ANDERSON
Montrose, Colorado

I want to say *mahalo nui loa* (thank you very much) for your piece about Hawaiians reclaiming our culture. I attended Kamehameha Schools and have the utmost pride to be Hawaiian. The experience allowed me and my fellow classmates to learn our language, culture, and history. It was an invaluable opportunity because our culture has been raped by the American government, American businessmen, and Christian missionaries, which left my mother not knowing very much about her culture because the teaching of hula and the speaking of the language were frowned upon. I now live in the Washington, D.C., area and haven't been to Hawaii in over four years. The article made me feel close to home.

NAPUALOKELANI S. WILEY
Alexandria, Virginia

Hawaiians shouldn't bite the hand that protects them. Had the Japanese taken the islands during World War II, would there remain enough native culture to preserve?

D. HAMPTON
Shady Point, Oklahoma

I must offer the highest praise for the article on the Hawaiian people. Decades of showbiz stereotypes and tourist industry trivialization have made it difficult for Hawaiians to convey the dignity, complexity, and

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Corner stop
to
daughter's house
to
spoiling granddaughter rotten.

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The Search for *PT 109*

Why were John F. Kennedy and his crew "astonished to see a massive shape appear out of the moonless night"? Isn't that what they were waiting for? I'm sorry to see NATIONAL GEOGRAPHIC perpetuate the Kennedy-as-hero myth.

BARBARA ELLISON
Folsom, California

ART BY TOM FREEMAN

Until recently there was one part of the story of *PT 109* that I never could understand: How could a boat that was capable of doing 45 knots, and which was on full combat alert, be run over by a Japanese destroyer? Then I had the good fortune to meet Dick Keresey, commander of *PT 105*. He is one of the few remaining people with special knowledge of the events of August 2, 1943—his boat had been on patrol with *PT 109*. I asked Keresey what might have gone wrong on that fateful night. "It could have happened to any of us," he said. "The fact that a PT boat could do 45 knots was no help if we were patrolling at six knots. It took time to get the boat up—it wasn't like taking a car from zero to sixty on a highway. And it was a very dark night, with no moon and heavy cloud cover. You couldn't see a thing out there. The only thing I saw was what I thought was a flare in the distance. It was only much later that I realized it was the fuel tanks of the *109* exploding."

JOSEPH PARKHURST
Arroyo Grande, California

We had to hunt for the names of the other crew members on *PT 109*, only to find a mere five of them mentioned. That boat was full of heroes. Just because they didn't become President does not mean that they were any less worthy.

JIMMY AND NANCY WADE
Newalla, Oklahoma

uniqueness of the real culture to those outside their community. Thank you for helping to begin a perception revolution.

MINDI REID
Issaquah, Washington

The name of University of Hawaii professor Lilikala Kame'eleihiwa is misspelled on pages 34 and 37. You incorrectly added "ha" to the ending.

NAOMI LOSCH
Kailua, Hawaii

The article began with a gatefold photograph of Hawaiian coastline. I've been to four different islands in Hawaii, but I didn't recognize the scene. What was depicted in the photo?

JIM ROSE
Alameda, California

It's the Na Pali Coast on the island of Kauai.

Surviving the Sahara

Perhaps I could ignore the pointlessness of another expedition, equipped with a satellite phone and global positioning system, replicating a long-ago journey of discovery. And perhaps I could disregard the self-important posturing of yet another superannuated adolescent embarking on a macho fantasy adventure, supported by Society funding. But it is hard to ignore the suffering on this journey of the camels, who endured extreme hunger and thirst because of John Hare's carelessness in provisioning, choice of personnel, and route planning—and his inexplicable failure, when his team became lost, to use the technology he brought along, when doing so could have alleviated the unnecessary suffering of the animals in his care.

DIANE L. HALL
Elgin, Texas

John Hare replies: The camels were checked individually every day, and the greatest care was taken of each one. They were never once short of water, but there was no way of knowing that their food supplies would become depleted. As I said in the article, "I felt shamed." The GPS had limited use in pointing the way across sand dunes. The satellite phone

WRITE TO FORUM

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was used to call up additional camel fodder, but, over the immense distances, this took time. A goal of the expedition was to raise awareness of Asia's endangered Bactrian camels, and the international response to that has been positive.

X-ray Vision

The feature concerning the orbiting Chandra X-ray Observatory was truly fascinating. However, where black holes are concerned, despite all the recent publicity, none has been positively identified. There has been a great deal of circumstantial support, but no candidate has yet satisfied the very simple requirement that, for a black hole, the ratio of mass to radius of the event horizon must exceed 6.7×10^{26} kg/m. This result was first derived by John Michell in 1784, and has been deduced more recently from the Schwarzschild metric.

J. DUNNING-DAVIES
Department of Physics
University of Hull
Kingston upon Hull, England

Using Newton's laws of mechanics, John Michell was the first to postulate the existence of what we now call black holes. Karl Schwarzschild in 1916 showed that Einstein's theory of general relativity allows for black holes, though Einstein didn't think they existed. Observable evidence of black holes—bolstered by Chandra and the Hubble Space Telescope—is now so convincing that virtually all scientists consider them a reality.

A New Day in Kabul

I was disappointed by the article on Kabul. This sentence, "From a bloody coup in 1978, to the Soviet war, to bitter factional fighting in the early 1990s, through stifling Taliban rule, the nation has known only hardship, with many of its towns and cities turned to ruins," left me amazed. Where is the mention of the U.S. bombing? Afghanistan has been attacked by the world's only superpower, and this huge fact was omitted.

PEGGY MUNSON ENTZ
Three Rivers, California

Where black holes are concerned, despite all the recent publicity, none has been positively identified. There has been . . . circumstantial support.

I thoroughly enjoyed "A New Day in Kabul." The freedoms the Afghans are experiencing today are due largely to the United States. However, not once in your article did I read of an Afghan showing appreciation toward America. When America liberated countries during World War II, the citizens thanked us sincerely.

MICHAEL DUKES
Toronto, Ohio

Snowy Owls

I was disturbed by the sight of the tagging device on a female owl. The device clearly allows the owl to fly, but won't other owls notice the antenna on its back and be bothered by it? Can a female bird carrying an antenna still mate? Is there any plan to rid the birds of the device once it becomes useless?

IOANA MANOLESCU
Paris, France

The small, lightweight tracking device strapped to the snowy owls is placed between the wings and has a flexible antenna. Researchers don't know whether it interferes with mating, but the tracking data show that Female 2 was stationary for a long enough period of time in 2000 to have bred and nested. The scientists have no plans to recapture the birds to remove the harness, which may naturally loosen and fall off.

Behind the Scenes: *Geography Poll*

I'm a veteran geographer who has been involved with the education of students in England, Canada, and the United States over the past four decades. In the U.S., I have encountered an almost complete absence of a K-12 curriculum for geography. There is no vehicle available right now to deliver the skills and concepts of geography. Instead, geography is fit into science and social studies curricula whenever there is time. It is not the students' fault. Nor is it the fault of teachers. The fault rests entirely upon those state education departments that have failed to respond to the relevance of geography.

ROBERT C. LORD
Amherst, New York

Since the Society's first geography poll in 1988 we've worked with departments of education to improve classroom teaching by creating Geographic Alliances in each state. You can find information on our teaching resources at national geographic.com/education.

Clouded Leopard *(Neofelis nebulosa)*
Size: Head and body length, 75-105 cm; tail, 80-90 cm; shoulder height, 25-40 cm
Weight: 16-30 kg **Habitat:** Forests of Southeast Asia
Surviving number: Unknown; populations declining

Photographed by Fred Wolff

WILDLIFE AS CANON SEES IT

The clouded leopard is not a leopard. Literally one of a kind, it is a separate species thought to be an evolutionary link between big and smaller cats. The reclusive carnivore's climbing puts most cats to shame; a long, balancing tail and swiveling ankle joints allow it to climb underneath tree branches, hang from branches by its hind feet and descend head first. Though it passes much of the day resting in the trees, it most often takes to the ground at night to hunt. The clouded leopard is hunted as well as hunter, prized for its distinctive fur, its large teeth and even for its bones, which are believed by some to have healing powers.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place —today and tomorrow.

NATURE

Canon

REFUGEES

Journey's End

Sudan's "lost boys" finally find a home

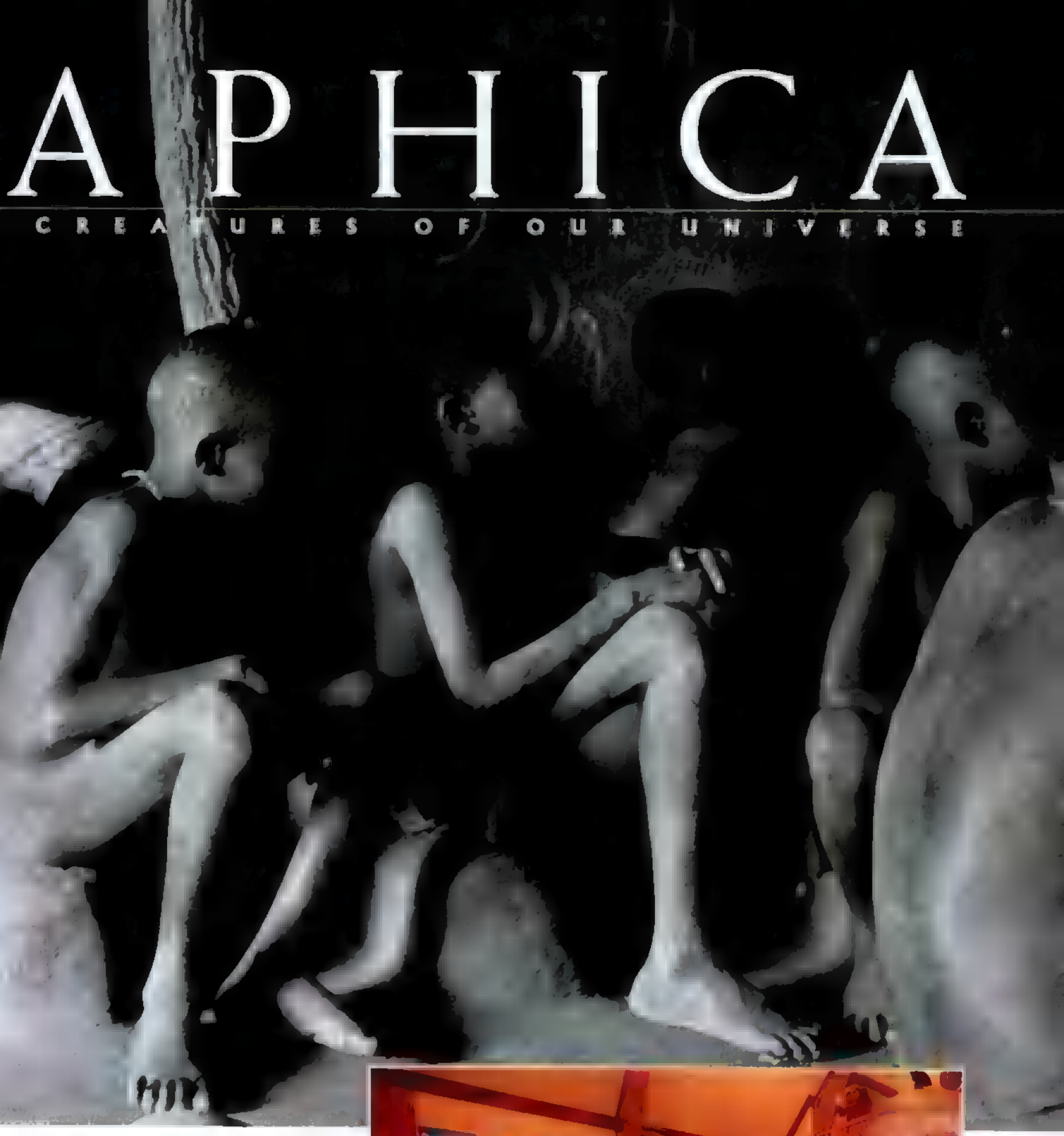
The children who would later become the "lost boys" of Sudan were taught the Gospel in missionary-founded churches (above), but not that humans had landed on the moon. Only dimly aware of what lay beyond their country's borders, they were ill prepared for the epic journey into the modern world forced upon them by Sudan's civil war.

In the late 1980s, government troops attacked camps where boys were caring for cattle far from their villages. Separated from their families, thousands of boys fled the country on foot. Those who dropped along the way were left unburied. Water was rationed by the teaspoon. The boys sought safety in Ethiopia and Kenya, some journeying more than a thousand miles. Over the past three years, the State Department has resettled 3,600 here in the United States.

Abraham Malou Mac (right), who thinks he is 22, arrived in Michigan with an assigned birthday of January 1, owing the U.S. government for his plane ticket, and with only the vaguest idea of how to open a car door. But local church members and a caring neighbor became surrogate parents to Abraham and seven other "boys" placed in Grand Haven, a small city that is 96 percent white. Within a year all had jobs. Four, including Abraham, own cars. Groups

APHICA

CREATURES OF OUR UNIVERSE



of four pay the rent on a pair of two-bedroom apartments.

On one Sunday Abraham opened worship at the First Christian Reformed Church with a hymn in Dinka, his native language. Abraham says he is grateful for the comforts of Middle America, but also for the faith he learned through hardship. "Americans believe in God," he says, "but they don't know what God can do."

—Karen E. Lange

ABBAS, MAGNUM PHOTOS (TOP); PENNY DE LOS SANTOS (ABOVE)

MERLIN D. TUTTLE, BAT CONSERVATION INTERNATIONAL

NGS RESEARCH GRANT

Bats Bring Rain Forest Back

In French Guiana a new discovery has led to a better understanding of how rain forests denuded by logging rebound. The forests return with the help of tough little fruits from *Cecropia* trees and some beneficial bats. National Geographic Society grantee Scott Mori and his colleague Tatyana Lobova, both of the New York Botanical Garden, count the discovery as one of the nearly 4,000 bat-plant interactions they've recorded so far.

The short-tailed leaf-nosed bat pictured above is feeding on one of the *Cecropia*'s fingerlike extensions. Each extension contains thousands of tiny fruits surrounded by fleshy floral parts; every fruit encloses a minuscule seed. Worldwide, bats aid the spread of plants by simply eating their fruit and defecating the seeds as they fly. In this case the *Cecropia*'s unusual fruit makes bats especially useful in reforesting. "It turns out that the bats digest only the floral parts and defecate the fruit intact," says Lobova. "The *Cecropia*'s fruit is protected by a tough coat that allows fruit and seed to survive in the soil for as long as nine years after the bats drop it."

That's why *Cecropia* seeds can survive logging. They may lie dormant in the shade until after an area is cleared. When the sun floods down, a thicket of *Cecropias* soon rises. Its shade allows other tree species to grow. "Remove bats from the process and you'd really slow down forest regeneration," says Mori.

—John L. Eliot

WEBSITE EXCLUSIVE

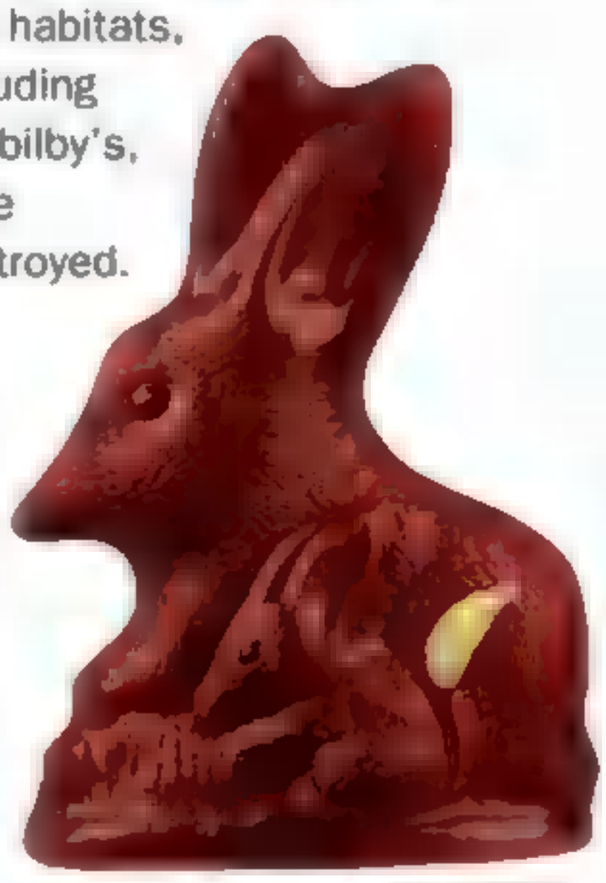
Find links and resources selected by our Research Division ■ **nationalgeographic.com/ngm/resources/0304.**

WHAT IS IT?

A chocolate Easter bilby, made by Australian candymakers.

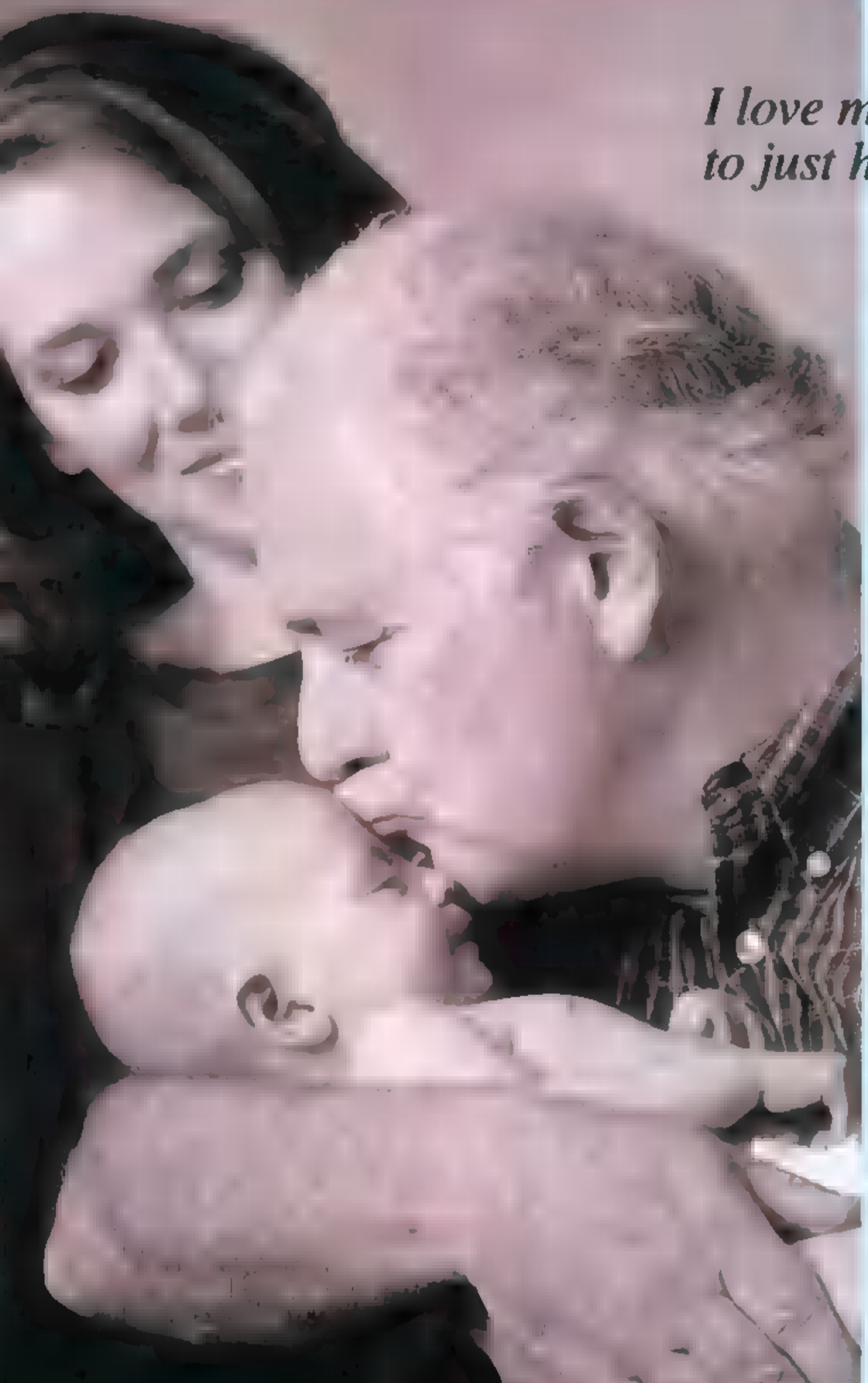
What's a bilby?
A long-eared marsupial from Australia. Once common, now threatened.

Why not an Easter bunny?
Australians don't like bunnies. After rabbits were introduced from Europe in the 1800s, they did what rabbits do—ate and multiplied—until croplands and habitats, including the bilby's, were destroyed.



JASON EDWARDS

Fighting Back with Aricept®



I love my life way too much to just hand it over to Alzheimer's.

*When my memory started failing, I knew I had to see my doctor. He put me on ARICEPT.® Now I'm doing better.**

If a person forgets names, places or facts – and has trouble with everyday things like reading or shopping – it may not be normal aging. It could be Alzheimer's disease. So it's important to see a doctor as soon as you can.

There is no cure for Alzheimer's. But a prescription drug called ARICEPT® has been used by millions of people to help their symptoms.

In studies, ARICEPT® has been proven to work for mild to moderate Alzheimer's. It has helped people improve their memory over time. It has also helped them to keep doing everyday things on their own, longer.

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ARICEPT®

(donepezil HCl)

5 MG AND 10 MG TABLETS

Strength in the face of Alzheimer's™

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*Individual responses to ARICEPT® can be different – people may get better, stay the same or not get better.

ARICEPT® is well tolerated but may not be for everyone. Some people may experience nausea, diarrhea, not sleeping well, vomiting, muscle cramps, feeling very tired, or not wanting to eat. In studies, these side effects were usually mild and went away over time. Some people taking ARICEPT® may experience fainting. People at risk for ulcers should tell their doctors because their condition may get worse.

Please see additional important product information on accompanying page.

ONCE A DAY

ARICEPT® (donepezil HCl) 5-mg and 10-mg tablets

STRENGTH IN THE FACE OF ALZHEIMER'S™

ARICEPT® (Donepezil Hydrochloride Tablets)

Brief Summary—see package insert for full prescribing information. **INDICATIONS AND USAGE** ARICEPT® is indicated for the treatment of mild to moderate dementia of the Alzheimer's type. **CONTRAINDICATIONS** ARICEPT® is contraindicated in patients with known hypersensitivity to donepezil hydrochloride or to piperidine derivatives. **WARNINGS** ***Anesthesia:*** ARICEPT®, as a cholinesterase inhibitor, is likely to exaggerate succinylcholine-type muscle relaxation during anesthesia. ***Cardiovascular Conditions:*** Because of their pharmacological action, cholinesterase inhibitors may have vagotonic effects on the sinoatrial and atrioventricular nodes. This effect may manifest as bradycardia or heart block in patients both with and without known underlying cardiac conduction abnormalities. Syncopal episodes have been reported in association with the use of ARICEPT®. ***Gastrointestinal Conditions:*** Through their primary action, cholinesterase inhibitors may be expected to increase gastric acid secretion due to increased cholinergic activity. Therefore, patients should be monitored closely for symptoms of active or occult gastrointestinal bleeding, especially those at increased risk for developing ulcers, e.g., those with a history of ulcer disease or those receiving concurrent nonsteroidal anti-inflammatory drugs (NSAIDS). Clinical studies of ARICEPT® have shown no increase, relative to placebo, in the incidence of either peptic ulcer disease or gastrointestinal bleeding. ARICEPT®, as a predictable consequence of its pharmacological properties, has been shown to produce diarrhea, nausea and vomiting. These effects, when they occur, appear more frequently with the 10 mg/day dose than with the 5 mg/day dose. In most cases, these effects have been mild and transient, sometimes lasting one to three weeks, and have resolved during continued use of ARICEPT®. ***Genitourinary:*** Although not observed in clinical trials of ARICEPT®, cholinomimetics may cause bladder outflow obstruction. ***Neurological Conditions:*** Seizures. Cholinomimetics are believed to have some potential to cause generalized convulsions. However, seizure activity also may be a manifestation of Alzheimer's Disease. ***Pulmonary Conditions:*** Because of their cholinomimetic actions, cholinesterase inhibitors should be prescribed with care to patients with a history of asthma or obstructive pulmonary disease. **PRECAUTIONS Drug-Drug Interactions** ***Drugs Highly Bound to Plasma Proteins:*** Drug displacement studies have been performed *in vitro* between this highly bound drug (96%) and other drugs such as furosemide, digoxin, and warfarin. ARICEPT® at concentrations of 0.3-10 µg/mL did not affect the binding of furosemide (5 µg/mL), digoxin (2 ng/mL), and warfarin (3 µg/mL) to human albumin. Similarly, the binding of ARICEPT® to human albumin was not affected by furosemide, digoxin, and warfarin. ***Effect of ARICEPT® on the Metabolism of Other Drugs:*** No *in vivo* clinical trials have investigated the effect of ARICEPT® on the clearance of drugs metabolized by CYP 3A4 (e.g. cisapride, terfenadine) or by CYP 2D6 (e.g. imipramine). However, *in vitro* studies show a low rate of binding to these enzymes (mean K_i about 50-130 µM), that, given the therapeutic plasma concentrations of donepezil (164 nM), indicates little likelihood of interference. Whether ARICEPT® has any potential for enzyme induction is not known. ***Effect of Other Drugs on the Metabolism of ARICEPT®:*** Ketoconazole and quinidine, inhibitors of CYP450 3A4 and 2D6, respectively, inhibit donepezil metabolism *in vitro*. Whether there is a clinical effect of these inhibitors is not known. Inducers of CYP 2D6 and CYP 3A4 (e.g., phenytoin, carbamazepine, dexamethasone, rifampin, and phenobarbital) could increase the rate of elimination of ARICEPT®. ***Use with Anticholinergics:*** Because of their mechanism of action, cholinesterase inhibitors have the potential to interfere with the activity of anticholinergic medications. ***Use with Cholinomimetics and Other Cholinesterase Inhibitors:*** A synergistic effect may be expected when cholinesterase inhibitors are given concurrently with succinylcholine, similar neuromuscular blocking agents or cholinergic agonists such as bethanechol. **Carcinogenesis, Mutagenesis, Impairment of Fertility** Carcinogenicity studies of donepezil have not been completed. Donepezil was not mutagenic in the Ames reverse mutation assay in bacteria, in the chromosome aberration test in cultures of Chinese hamster lung (CHL) cells, some clastogenic effects were observed. Donepezil was not clastogenic in the *in vivo* mouse micronucleus test. Donepezil had no effect on fertility in rats at doses up to 10 mg/kg/day (approximately 8 times the maximum recommended human dose on a mg/m² basis). **Pregnancy** ***Pregnancy Category C:*** Teratology studies conducted in pregnant rats at doses up to 16 mg/kg/day (approximately 13 times the maximum recommended human dose on a mg/m² basis) and in pregnant rabbits at doses up to 10 mg/kg/day (approximately 16 times the maximum recommended human dose on a mg/m² basis) did not disclose any evidence for a teratogenic potential of donepezil. However, in a study in which pregnant rats were given up to 10 mg/kg/day (approximately 8 times the maximum recommended human dose on a mg/m² basis) from day 17 of gestation through day 20 postpartum, there was a slight increase in stillbirths and a slight decrease in pup survival through day 4 postpartum at this dose, the next lower dose tested was 3 mg/kg/day. There are no adequate or well-controlled studies in pregnant women. ARICEPT® should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Nursing Mothers** It is not known whether donepezil is excreted in human breast milk. ARICEPT® has no indication for use in nursing mothers. **Pediatric Use** There are no adequate and well-controlled trials to document the safety and efficacy of ARICEPT® in any illness occurring in children. **ADVERSE REACTIONS Adverse Events Leading to Discontinuation** The rates of discontinuation from controlled clinical trials of ARICEPT® due to adverse events for the ARICEPT® 5 mg/day treatment groups were comparable to those of placebo-treatment groups at approximately 5%. The rate of discontinuation of patients who received 7-day escalations from 5 mg/day to 10 mg/day was higher at 13%. The most common adverse events leading to discontinuation, defined as those occurring in at least 2% of patients and at twice the incidence seen in placebo patients, are shown in Table 1.

Table 1. Most Frequent Adverse Events Leading to Withdrawal from Controlled Clinical Trials by Dose Group

Dose Group	Placebo	5 mg/day ARICEPT®	10 mg/day ARICEPT®
Patients Randomized	355	360	315
Event/% Discontinuing			
Nausea	1%	1%	3%
Diarrhea	0%	<1%	3%
Vomiting	<1%	<1%	2%

Most Frequent Adverse Clinical Events Seen in Association with the Use of ARICEPT® The most common adverse events, defined as those occurring at a frequency of at least 5% in patients receiving 10 mg/day and twice the placebo rate, are largely predicted by ARICEPT®'s cholinomimetic effects. These include nausea, diarrhea, insomnia, vomiting, muscle cramp, fatigue and anorexia. These adverse events were often of mild intensity and transient, resolving during continued ARICEPT® treatment without the need for dose modification. There is evidence to suggest that the frequency of these common adverse events may be affected by the rate of titration. An open-label study was conducted with 269 patients who received placebo in the 15- and 30-week studies. These patients were titrated to a dose of 10 mg/day over a 6-week period. The rates of common adverse events were lower than those seen in patients titrated to 10 mg/day over one week in the controlled clinical trials and were comparable to those seen in patients on 5 mg/day. See Table 2 for a comparison of the most common adverse events following one and six week titration regimens.

Table 2. Comparison of Rates of Adverse Events in Patients Titrated to 10 mg/day Over 1 and 6 Weeks

	No titration		One-week titration	Six-week titration
Adverse Event	**Placebo (n=315)**	**5 mg/day (n=311)**	**10 mg/day (n=315)**	**10 mg/day (n=269)**
Nausea	6%	5%	19%	6%
Diarrhea	5%	8%	15%	9%
Insomnia	6%	6%	14%	6%
Fatigue	3%	4%	8%	3%
Vomiting	3%	3%	8%	5%
Muscle cramps	2%	6%	8%	3%
Anorexia	2%	3%	7%	3%

Adverse Events Reported in Controlled Trials The events cited reflect experience gained under closely monitored conditions of clinical trials in a highly selected patient population. In actual clinical practice or in other clinical trials, these frequency estimates may not apply, as the conditions of use, reporting behavior, and the kinds of patients treated may differ. Table 3 lists treatment emergent signs and symptoms that were reported in at least 2% of patients in placebo-controlled trials who received ARICEPT® and for which the rate of occurrence was greater for ARICEPT® assigned than placebo assigned patients. In general, adverse events occurred more frequently in female patients and with advancing age.

Table 3. Adverse Events Reported in Controlled Clinical Trials in at Least 2% of Patients Receiving ARICEPT® (donepezil HCl) and at a Higher Frequency than Placebo-treated Patients

Body System/Adverse Event	Placebo (n=355)	ARICEPT® (n=747)
Percent of Patients with any Adverse Event	72	74
Body as a Whole		
Headache	9	10
Pain, various locations	8	9
Accident	6	7
Fatigue	3	5
Cardiovascular System		
Syncope	1	2
Digestive System		
Nausea	6	11
Diarrhea	5	10
Vomiting	3	5
Anorexia	2	4
Hemic and Lymphatic System		
Ecchymosis	3	4
Metabolic and Nutritional Systems		
Weight Decrease	1	3
Musculoskeletal System		
Muscle Cramps	2	6
Arthritis	1	2
Nervous System		
Insomnia	6	9
Dizziness	6	8
Depression	<1	3
Abnormal Dreams	0	3
Somnolence	<1	2
Urogenital System		
Frequent Urination	1	2

Other Adverse Events Observed During Clinical Trials ARICEPT® has been administered to over 1700 individuals during clinical trials worldwide. Approximately 1200 of those patients have been treated for at least 3 months and more than 1000 patients have been treated for at least 6 months. Controlled and uncontrolled trials in the United States included approximately 900 patients. In regards to the highest dose of 10 mg/day, this population includes 650 patients treated for 3 months, 475 patients treated for 6 months and 116 patients treated for over 1 year. The range of patient exposure is from 1 to 1214 days. Treatment emergent signs and symptoms that occurred during 3 controlled clinical trials and two open-label trials in the United States were recorded as adverse events by the clinical investigators using terminology of their own choosing. To provide an overall estimate of the proportion of individuals having similar types of events, the events were grouped into a smaller number of standardized categories using a modified COSTART dictionary and event frequencies were calculated across all studies. These categories are used in the listing below. The frequencies represent the proportion of 900 patients from these trials who experienced that event while receiving ARICEPT®. All adverse events occurring at least twice are included, except for those already listed in Tables 2 or 3, COSTART terms too general to be informative, or events less likely to be drug caused. Events are classified by body system and listed using the following definitions: *frequent adverse events*—those occurring in at least 1/100 patients; *infrequent adverse events*—those occurring in 1/100 to 1/1000 patients. These adverse events are not necessarily related to ARICEPT® treatment and in most cases were observed at a similar frequency in placebo-treated patients in the controlled studies. No important additional adverse events were seen in studies conducted outside the United States. **Body as a Whole:** *Frequent:* influenza, chest pain, toothache, *Infrequent:* fever, edema face, periorbital edema, hernia hiatal, abscess, cellulitis, chills, generalized coldness, head fullness, listlessness. **Cardiovascular System:** *Frequent:* hypertension, vasodilation, atrial fibrillation, hot flashes, hypotension. *Infrequent:* angina pectoris, postural hypotension, myocardial infarction, AV block (first degree), congestive heart failure, arteritis, bradycardia, peripheral vascular disease, supraventricular tachycardia, deep vein thrombosis. **Digestive System:** *Frequent:* fecal incontinence, gastrointestinal bleeding, bloating, epigastric pain, *Infrequent:* eructation, gingivitis, increased appetite, flatulence, periodontal abscess, cholelithiasis, diverticulitis, drooling, dry mouth, fever sore, gastritis, irritable colon, tongue edema, epigastric distress, gastroenteritis, increased transaminases, hemorrhoids, ileus, increased thirst, parotitis, melena, polydipsia, duodenal ulcer, stomach ulcer. **Endocrine System:** *Infrequent:* diabetes mellitus, goiter. **Hemic and Lymphatic System:** *Infrequent:* anemia, thrombocythemia, thrombocytopenia, eosinophilia, erythrocytopenia. **Metabolic and Nutritional Disorders:** *Frequent:* dehydration. *Infrequent:* gout, hypokalemia, increased creatine kinase, hyperglycemia, weight increase, increased lactate dehydrogenase. **Musculoskeletal System:** *Frequent:* bone fracture; *Infrequent:* muscle weakness, muscle fasciculation. **Nervous System:** *Frequent:* delusions, tremor, irritability, paresthesia, aggression, vertigo, ataxia, increased libido, restlessness, abnormal crying, nervousness, aphasia; *Infrequent:* cerebrovascular accident, intracranial hemorrhage, transient ischemic attack, emotional lability, neuralgia, coldness (localized), muscle spasm, dysphoria, gait abnormality, hypertonia, hypokinesia, neurodermatitis, numbness (localized), paranoia, dysarthria, dysphasia, hostility, decreased libido, melancholia, emotional withdrawal, nystagmus, pacing. **Respiratory System:** *Frequent:* dyspnea, sore throat, bronchitis; *Infrequent:* epistaxis, post nasal drip, pneumonia, hyperventilation, pulmonary congestion, wheezing, hypoxia, pharyngitis, pleurisy, pulmonary collapse, sleep apnea, snoring. **Skin and Appendages:** *Frequent:* pruritus, diaphoresis, urticaria; *Infrequent:* dermatitis, erythema, skin discoloration, hyperkeratosis, alopecia, fungal dermatitis, herpes zoster, hirsutism, skin striae, night sweats, skin ulcer. **Special Senses:** *Frequent:* cataract, eye irritation, vision blurred; *Infrequent:* dry eyes, glaucoma, earache, tinnitus, blepharitis, decreased hearing, retinal hemorrhage, otitis externa, otitis media, bad taste, conjunctival hemorrhage, ear buzzing, motion sickness, spots before eyes. **Urogenital System:** *Frequent:* urinary incontinence, nocturia; *Infrequent:* dysuria, hematuria, urinary urgency, metrorrhagia, cystitis, enuresis, prostate hypertrophy, pyelonephritis, inability to empty bladder, breast fibroadenosis, fibrocystic breast, mastitis, pyuria, renal failure, vaginitis. **Postintroduction Reports** Voluntary reports of adverse events temporally associated with ARICEPT® that have been received since market introduction that are not listed above, and that there is inadequate data to determine the causal relationship with the drug include the following: abdominal pain, agitation, cholecystitis, confusion, convulsions, hallucinations, heart block (all types), hemolytic anemia, hepatitis, hyponatremia, neuroleptic malignant syndrome, pancreatitis, and rash. **OVERDOSAGE Because strategies for the management of overdose are continually evolving, it is advisable to contact a Poison Control Center to determine the latest recommendations for the management of an overdose of any drug.** As in any case of overdose, general supportive measures should be utilized. Overdosage with cholinesterase inhibitors can result in cholinergic crisis characterized by severe nausea, vomiting, salivation, sweating, bradycardia, hypotension, respiratory depression, collapse and convulsions. Increasing muscle weakness is a possibility and may result in death if respiratory muscles are involved. Tertiary anticholinergics such as atropine may be used as an antidote for ARICEPT® overdosage. Intravenous atropine sulfate titrated to effect is recommended: an initial dose of 1.0 to 2.0 mg IV with subsequent doses based upon clinical response. Atypical responses in blood pressure and heart rate have been reported with other cholinomimetics when co-administered with quaternary anticholinergics such as glycopyrrolate. It is not known whether ARICEPT® and/or its metabolites can be removed by dialysis (hemodialysis, peritoneal dialysis, or hemofiltration). Dose-related signs of toxicity in animals included reduced spontaneous movement, prone position, staggering gait, lacrimation, clonic convulsions, depressed respiration, salivation, miosis, tremors, fasciculation and lower body surface temperature.

Eisai Inc. Pfizer U.S. Pharmaceuticals

200177 Revised December 2000

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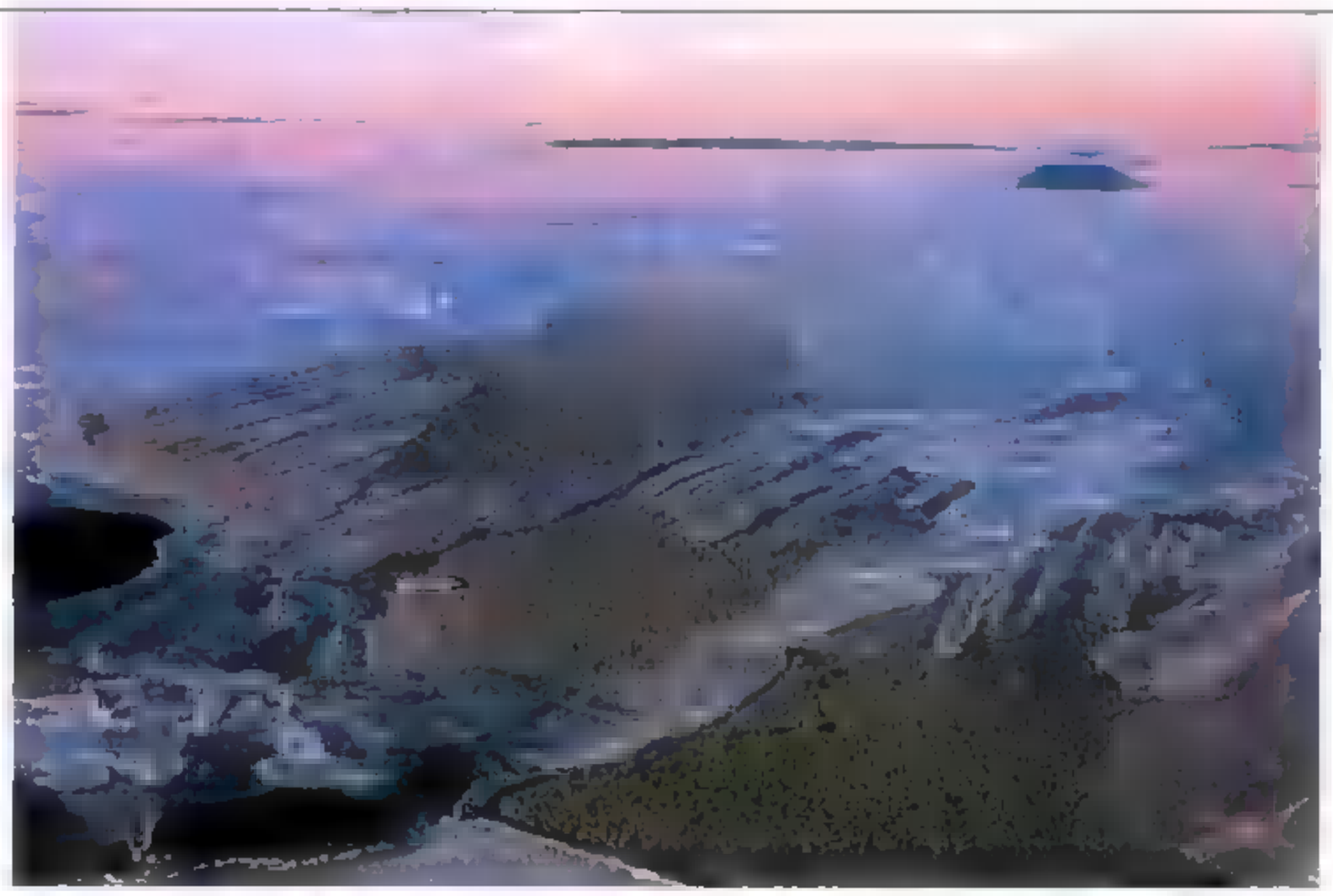
ECOLOGY

Oases in the Polar Desert

Polynyas: spas for icy life



PATRICE HALLEY (ALL)

Beneath ever shifting ice in the polar oceans thrives a rich ecosystem, from plankton to whales. It's hard to see and hard to study. Fortunately, parts of these waters never completely freeze. These ice windows are polynyas—hot spots for life.

Dozens of polynyas perforate the Arctic and Antarctic. Although thin ice forms, the pools are kept fluid by winds, tides, currents, and warm upwellings. Polynyas can be less than a square mile or even larger than the 30,000-square-mile North Water Polynya in the Canadian Arctic, between Greenland and Ellesmere Island (top). Patrice Halley took this unusual photograph from atop an icebreaker. As clear thin ice sheets formed, salt in the ice was extruded to create grainy mats of "salt flowers," as ice expert Dave Barber of the University of Manitoba calls them.

The flowers appear in the spring as pools of open water expand. Within the polynyas sunlight triggers blooms of algae and phytoplankton, the base of the marine food web. Tiny crustaceans called copepods (below)—superabundant here—graze on the microscopic marine plants. The copepods feed bowhead whales and arctic cod. The cod in turn are a banquet for belugas and ringed seals (bottom).

This polynya is richer than any other in the Canadian Arctic "because the algae production season is so long, four to five months, and the surface water temperatures are higher," says Louis Fortier, leader of the International North Water Polynya Study. Since the polynya is essentially an ice-free system, Fortier's researchers are also using it as a scale model to study how the entire Arctic Ocean might respond to ice melt amid global climate change. —*John L. Eliot*

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MONUMENTS

Mont-Saint-Michel vs. Mud

Making a French icon back into an island

REUTERS

Attached to the Normandy mainland by a causeway for 124 years and surrounded by an ever growing pile of sediments, the rocky outcropping that's home to the abbey of Mont-Saint-Michel is about to become a true island again.

Since construction of the causeway, some 100 million cubic feet of sand and mud have accumulated around this UNESCO World Heritage site (here at low tide). Authorities realized that if the accumulation didn't stop, Mont-Saint-Michel would soon become part of the mainland.

So next year, a five-year construction project will allow the sea to encircle the 256-foot-high hunk of granite once again. A tidal barrier near the island will filter sediment, and a bridge will replace much of the causeway. No cars will be permitted; a shuttle will transport Mont-Saint-Michel's three million annual visitors—as well as the island's 50 villagers.

—Sylvie Brieu
NGM FRENCH EDITION

MARINE BIOLOGY

Square Peg or Round Whole?

A jellyfish's changing shape surprises a scientist

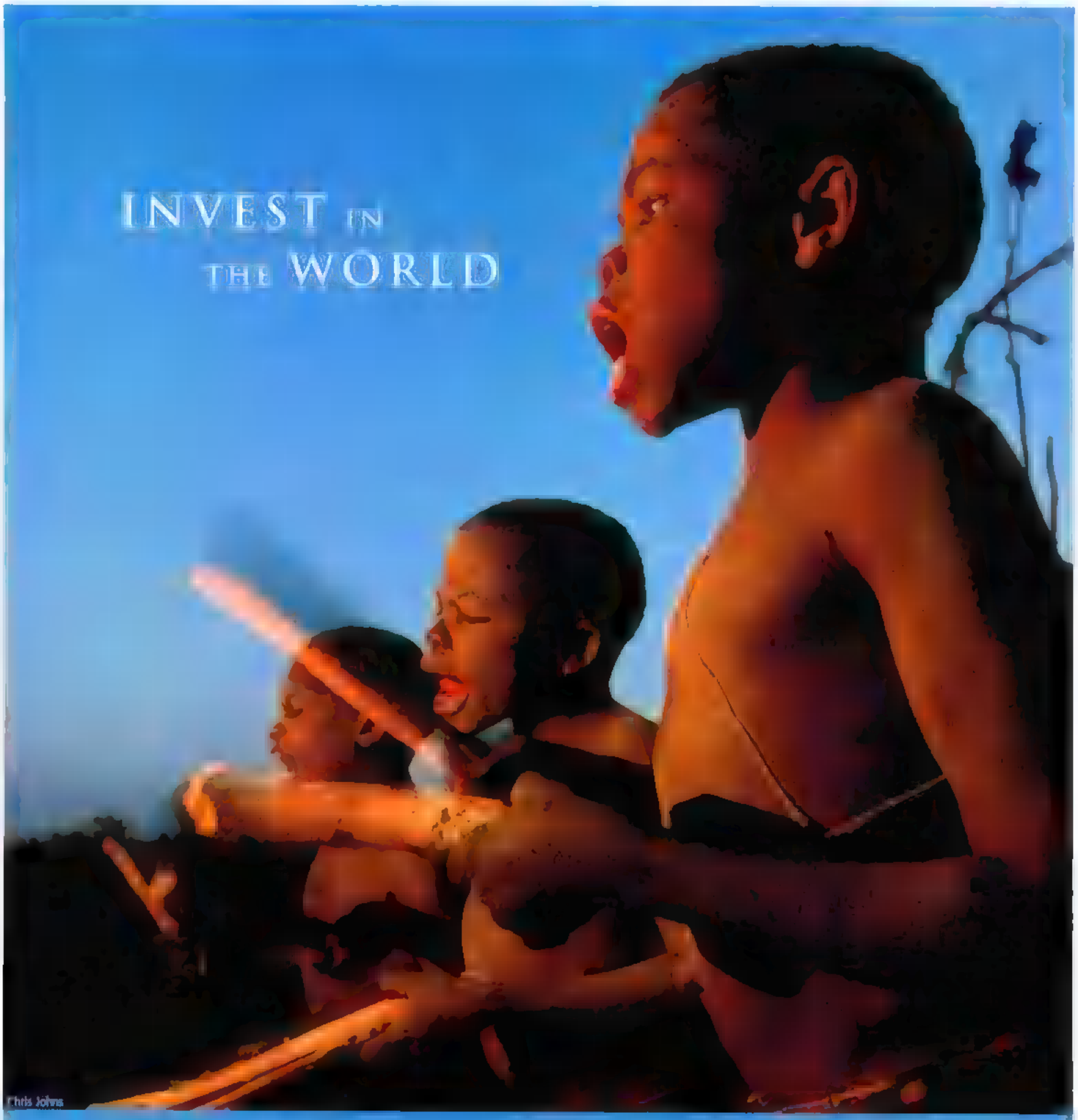
In Greek mythology, the gods transformed the ocean nymph Clytia into a flower. Until recently no one realized her namesake, the jellyfish *Clytia languidum*, could also change form. But marine biologist Edith Widder of Florida's Harbor Branch Oceanographic Institution has discovered that the little jelly transforms when touched.

Widder collected the shape-shifter, barely an inch in diameter, about 2,800 feet deep off the Bahamas using the *Johnson-Sea-Link I* submersible. In her lab *Clytia*'s round transparent body (top) revealed a lavender central stomach with four radial canals, each containing a white reproductive organ.

"When I touched its body, it changed into a square" (middle), she says. "This is really unusual for a jellyfish. I've only seen it once before." After she turned off the lab lights, the square glowed green with bioluminescent light (bottom). Widder is still working out why *Clytia* does this. "Perhaps the change acts like a skull and crossbones, a warning to predators such as fish or sea turtles," Widder says. "'Don't eat me or I'll sting you.'"

—John L. Eliot

EDITH WIDDER, HARBOR BRANCH OCEANOGRAPHIC INSTITUTION



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RUBEN SCHMIDT (ABOVE); STEPHEN L. ALVAREZ WITH APRIL ALVAREZ

Double Dutch

Working together comes naturally to twin artists

When they were 11 years old, twins Alfons and Adrie Kennis from the Netherlands visited London's Natural History Museum. Most children would have been attracted to the dinosaurs. "But what struck us was a giant giraffe and an incredibly big ground sloth," Alfons recalls. "They had much more character."

Twenty-five years later, the pair are still fascinated by prehistoric mammals large and small. Together they created the artwork for this issue's article on the rise of mammals, the latest example of their unusual partnership.

The artists (above, that's Alfons with the palette and Adrie with a clay model of a Pleistocene marsupial from Australia) travel together to European museums to collect information. Starting with casts or photos of fossil bones, they make miniature clay sculptures of animals, then light them to use as models for their paintings.

The twins live a ten-minute walk apart. Each works at home but regularly visits the other to look at art in progress. Any serious disagreements? "No," Alfons says. "Adrie thinks exactly as I do. We have more or less the same minds. We know what we like and don't like; we just talk about how to achieve perfection. It's impossible for us not to work together."

TOOLBOX

Mission Exploring the caves of Oman (see page 38).

Tool A mile of low-stretch, abrasion-resistant nylon rope in eight 656-foot-long spools.

Current use "You don't reuse rope for caving once it shows wear," says photographer Stephen Alvarez (below). It's now tethering farm animals.

AFTER DIANE KASTAMA LOST THE USE OF HER TWO LEGS,

she gained

THE STRENGTH OF FOUR.

An alarm clock buzzes. A horse outside whinnies. And a dog's lifework continues. Though never trained to help out on a horse ranch, this canine companion has made herself invaluable. Whether corralling horses, pulling her owner up a hill or just closing a door, she uses the full capacity of her mind and body from dawn to dusk. All the while, making the term "confined to a wheelchair" absolutely irrelevant. Meet Fritzie. An eight-year-old Yellow Lab who relies on her total body health to do her job. Which is why her owner feeds her Eukanuba.® The only dog food with the Vital Health System. By targeting six essential health functions of every dog, the Eukanuba Vital Health System™ delivers nutrients when and where they're needed for optimal health [see graphic].

All Eukanuba foods incorporate the Vital Health System, with unique formulas customized to meet the specific needs of different life stages.

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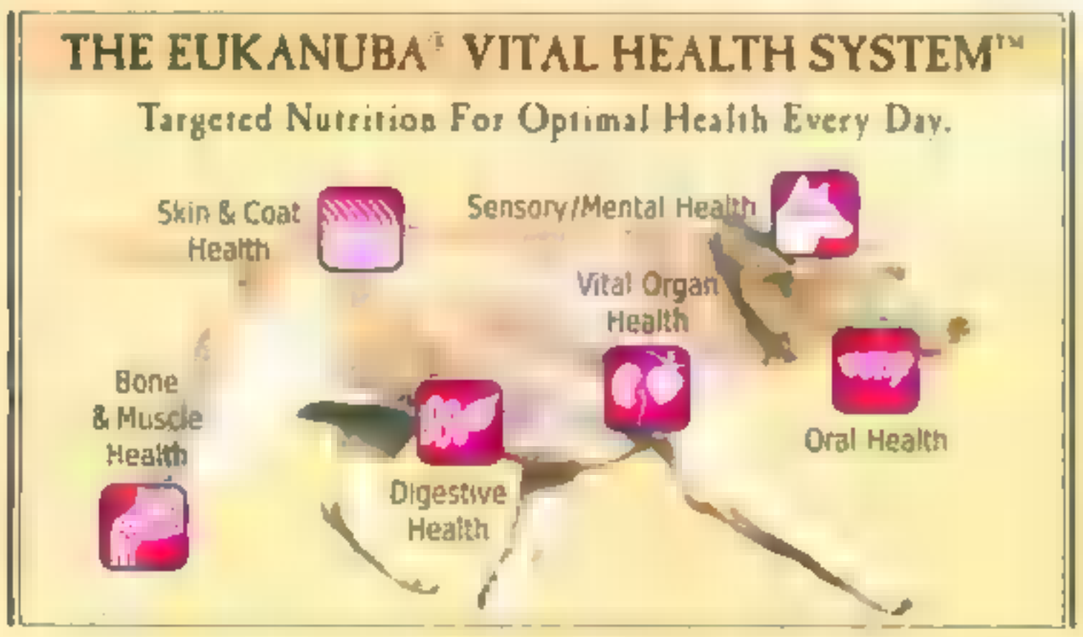

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Exposing a Phony Photo

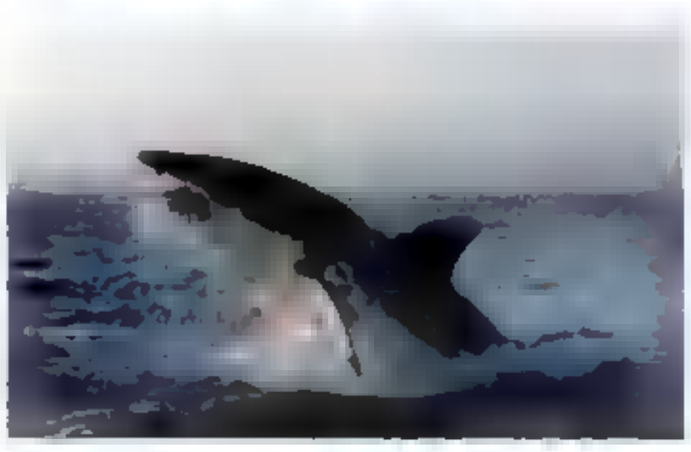
NGS website tells all

This is a tale of a hoax, and the power of the Internet both to spread it and to debunk it.

A photograph raced around the world via e-mail last summer that ostensibly was "nominated by NATIONAL GEOGRAPHIC as 'THE photo of the year.'" Its dramatic subject: a great white shark leaping out of the water to attack a person dangling from a helicopter near San Francisco's Golden Gate Bridge (right).

Problem is, it never happened. No nomination. No attack. The image was a composite of two other pictures. Or, in less polite terms, a fraud.

The hoax intrigued Society website news director David Braun. He and intern Stentor Danielson began to look for the original photos. In less than an hour they tracked the photo of the breaching shark to South African photographer Charles Maxwell, and the photo of the HH-60G Pave Hawk helicopter to U.S. Air Force photographer Lance Cheung. (Neither photographer had anything to do with the hoax.) Stentor and



David posted their findings at *nationalgeographic.com*, and word of the altered photos got around the Internet with help from America Online. The perpetrator was never found, but the story drew a record number of hits—nearly a million in a single day—to the Society's website. The page, with links to information about sharks, remains available at *news.nationalgeographic.com/news/2002/08/0815_020815_photooftheyear.html.*

FOR MORE INFORMATION

Call: 1-800-NGS-LINE
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NG Channel Show Wins Emmy

Tom Foreman (right) describes *Inside Base Camp*, his interview program on the National Geographic Channel, as "a late evening chat around the campfire with a person you always wanted to talk to." It works: *Inside Base Camp* won an Emmy for best interview show, a remarkable achievement for the Channel, which debuted in 2001. Few cable channels have ever won an Emmy so soon after their launch.

The award-winning edition of the program features Tom talking with veteran newsman Ted Koppel about war, hatred, and the roots of genocide. National Geographic EXPLORER also picked up two news and documentary Emmys.

MARK THIESSEN, NGS

Dorothy Hamill

MERCK

YOUR RESULTS MAY VARY.

"Morning pain can't keep me from doing what I love."

VIOXX PROVIDES POWERFUL 24-HOUR RELIEF OF OSTEOARTHRITIS.

It isn't about competing. Or pushing yourself to the limit. It's about controlling the pain that can keep you from doing the things that make your day worthwhile. VIOXX may help. VIOXX is a prescription medicine for arthritis pain and stiffness.

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You take VIOXX only once a day. Just one little pill can relieve your pain and stiffness all day and all night for a full 24 hours.

VIOXX TARGETS A KEY SOURCE OF PAIN.

VIOXX specifically targets only the COX-2 enzyme, which is a key source of pain and inflammation. In clinical studies, once-daily VIOXX effectively reduced pain and stiffness.

TAKE WITH OR WITHOUT FOOD.

VIOXX doesn't need to be taken with food. And it comes in both a tablet and a liquid for easy swallowing.

VIOXX IS NOT A NARCOTIC.

IMPORTANT INFORMATION ABOUT VIOXX.

People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX. In rare cases, serious stomach problems, such as bleeding, can occur without warning.

Tell your doctor if you have liver or kidney disease, or a history of angina, heart attack, or a blocked artery in your heart. VIOXX cannot take the place of aspirin for the prevention of heart attack or stroke. VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in large clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea, and high blood pressure. Report any unusual symptoms to your doctor.

FIND OUT IF VIOXX CAN MAKE A DIFFERENCE IN YOUR LIFE.

Ask your doctor or healthcare professional about VIOXX today. Call 1-800-MERCK-30 for more information, or visit **vioxx.com**. Please see the Patient Product Information for VIOXX on the next page for additional information that should be discussed with your doctor.

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Patient Information about
VIOXX® (rofecoxib tablets and oral suspension)
VIOXX® (pronounced "VI-ox")
for Osteoarthritis, Rheumatoid Arthritis and Pain
Generic name: rofecoxib ("ro-fa-COX-ib")

You should read this information before you start taking VIOXX®. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX ■ a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- relief of rheumatoid arthritis in adults
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- history of angina, heart attack or a blocked artery in your heart
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- serious stomach problems such as ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- warfarin (a blood thinner)
- theophylline (a medicine used to treat asthma)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

VIOXX cannot take the place of aspirin for prevention of heart attack or stroke. If you are currently taking aspirin for this purpose, you should not discontinue taking aspirin without consulting your doctor.

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Heart attacks and similar serious events have been reported in patients taking VIOXX.
- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing and wheezing occur rarely but may require treatment right away. Severe skin reactions have also been reported.
- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.
- Severe liver problems, including hepatitis, jaundice and liver failure, occur rarely ■ patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: anxiety, blurred vision, colitis, confusion, decreased levels of sodium in the blood, depression, fluid in the lungs, hair loss, hallucinations, increased levels of potassium in the blood, insomnia, low blood cell counts, menstrual disorder, palpitations, pancreatitis, severe increase in blood pressure, tingling sensation, unusual headache with stiff neck (aseptic meningitis), vertigo.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my arthritis pain?

Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis, rheumatoid arthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

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NGS PHOTOGRAPHER JODI COBB

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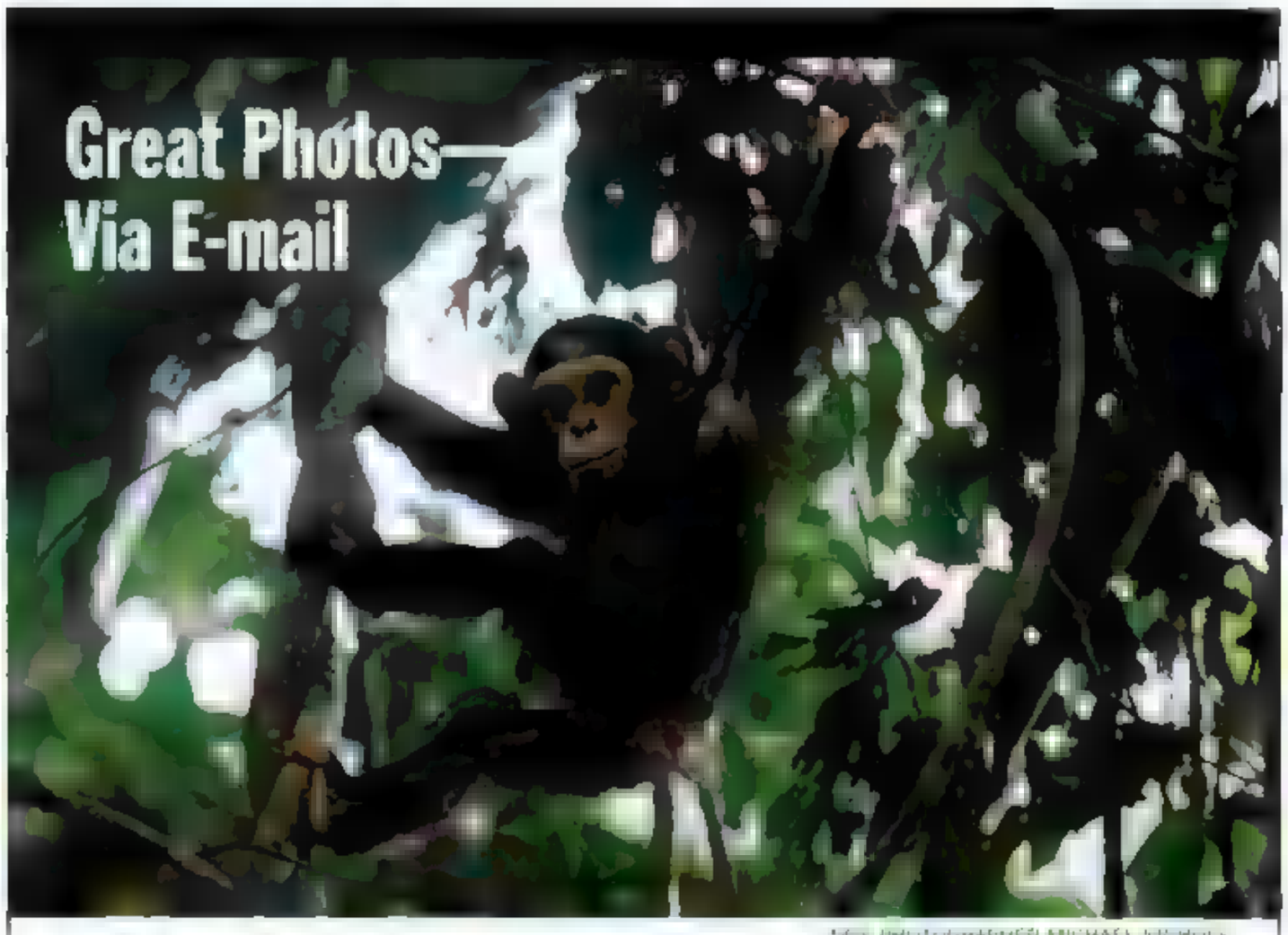

NGS PHOTOGRAPHER MICHAEL NICHOLS

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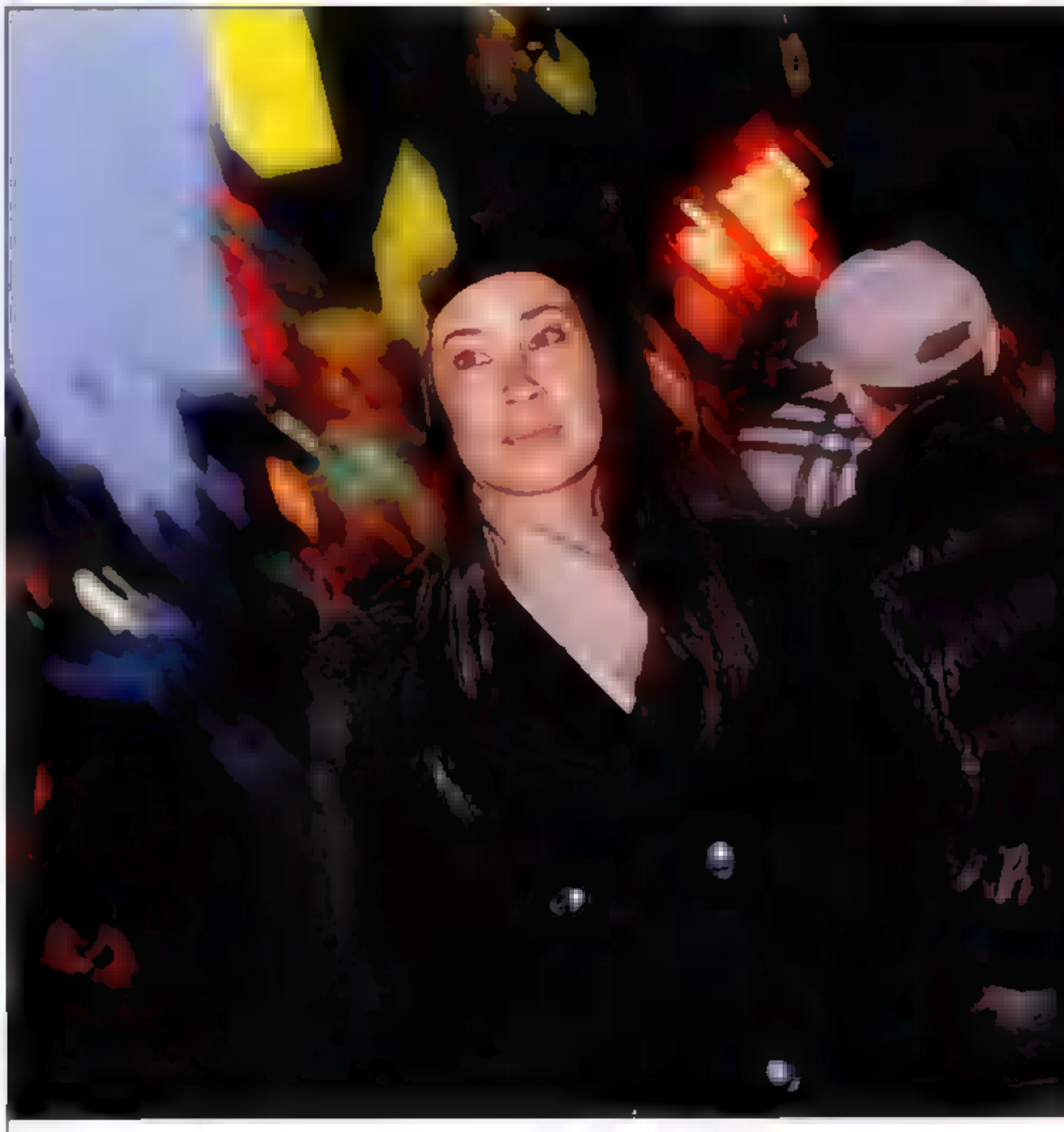
WATCH "SURVIVING EVEREST," APRIL 27, NATIONAL GEOGRAPHIC CHANNEL

National Geographic TV



NATIONAL GEOGRAPHIC EXPLORER, MSNBC

Lisa Ling

At home on the street and in the trenches, Lisa Ling brings energy, experience, and battle-tested toughness (Is she really only 29?) to National Geographic this June as the new host of EXPLORER, the Society's acclaimed documentary series. The former correspondent for Channel One and recent co-host of ABC's *The View* headed to China for her first assignment, a report on the country's new cultural revolution—basketball fever. Lisa's vision: "To be a vehicle through which people can experience the cultures of the world."

NATIONAL GEOGRAPHIC EXPLORER, MSNBC

Saving the Tibetan Antelope

BILL BERNSTEIN (TOP); GERARD AUBER

On a mission to help save the endangered Tibetan antelope, Rick Ridgeway wrestles gear across a remote stretch of the Tibetan Plateau. *Deadly Fashion* follows explorers searching for the antelope's calving grounds, while Lisa Ling investigates illegal sales of *shahtoosh* shawls made from its wool.

National Geographic EXPLORER MSNBC. Sundays, 8 p.m. ET/5 p.m. PT. **National Geographic Specials** PBS. See local listings. **National Geographic Videos, Kids Videos, and DVDs** Call 1-800-527-5162. **National Geographic Channel** Call your cable or satellite provider.

■ Programming information accurate at press time: consult local listings or our website at nationalgeographic.com

Who Knew?

PALEONTOLOGY

Fire and Ice

Big rocks, raging volcanoes, and a big chill

As mass extinctions go, the Cretaceous-Tertiary (K-T) die-off 65 million years ago was only moderately horrendous. Far worse, of course, was the Permian-Triassic extinction 250 million years ago, which obliterated about 90 percent of the planet's animal species. But the K-T extinction (never mind the peculiar acronym) is surely the most famous. It wiped out the dinosaurs and spawned a remarkably enduring scientific debate.

At least half of the animal species on Earth vanished at or around the K-T boundary. There was a time when scientists blamed volcanoes, falling sea levels, or a nearby supernova—or they threw up their hands and declared it a mystery.

In recent decades, however, an Earth-shattering idea has gained acceptance: A big rock did it. Physicist Luis Alvarez, his geologist son Walter Alvarez, and nuclear chemists Frank Asaro and Helen Michel published a paper in 1980 arguing that a mountain-size asteroid struck the planet and triggered the K-T extinction. In 1991 scientists declared that they'd found the remnants of the impact crater near the tip of the Yucatán Peninsula.

Beyond the immediate effects (tsunamis, earthquakes, shock waves, and no doubt a general feeling of dread and anxiety) there would have been residual calamities. Global wildfires may have torched 25 percent of the planet's biomass, while dust and soot shut down photosynthesis. The planet got dark, and perhaps very cold.

Yet the story doesn't end there. Today a vocal minority is complicating the picture by suggesting that the die-off could have been more gradual. Before the K-T impact event, several hundred thousand years of intense volcanism could have poisoned the atmosphere, argues Vincent Courtillot, a French geophysicist. He claims to have found proof that all the Earth's mass extinctions were associated with powerful flood basalt eruptions.

San Diego State biologist J. David Archibald also criticizes the single-cause theory. Comparing creatures in North America that survived the K-T event and those that didn't, he finds no pattern to support the asteroid scenario. Most turtles survived; most lizards didn't. Nearly half of mammals survived, while all those dinosaurs didn't. "It should have been more of an equal opportunity killer," he says.

Meanwhile, Princeton paleontologist Gerta Keller contends that multiple impacts contributed to a prolonged extinction over several hundred thousand years. The Yucatán crater predates the K-T boundary, she says, and certainly isn't the only killer.

But let's stay calm here. Many scientists still favor the single-cause scenario. "The data are overwhelming," points out David Fastovsky, a geobiologist at the University of Rhode Island. He argues that new research at the Hell Creek formation in North Dakota shows that a great number of species died suddenly at the end of the Cretaceous.

The lesson here is that science usually doesn't deal in absolutes. Rather, we search for explanations that, for the moment, seem better than any alternative. The big-rock theory isn't doomed to extinction, but you can bet that there are still plenty of surprises ahead in our study of the distant past.

—Joel Achenbach
WASHINGTON POST STAFF WRITER

CARY WOLINSKY

IT MATTERS

Two cheers for extinction?

Sure, it's grim for the species that get wiped out, but those that survive often enjoy ■ whole new world of opportunity. Take the story of clams and corals. Indiana University's Claudia Johnson, who studies reef evolution, says that familiar corals were the main reef builders nearly 200 million years ago. But during much of the age of dinosaurs, clams with giant coiled shells dominated the world's reefs. Those clams died out 65 million years ago, and corals took over again. The ecological shuffle-and-redeal that followed the Cretaceous-Tertiary extinction matters to humans because if the age of dinosaurs hadn't come to an end, there might never have been an age of mammals—and we might not be here to wonder how it all happened.

—Lynne Warren

WEBSITE EXCLUSIVE

Learn more about the K-T extinction—and find a link to Joel Achenbach's work—at **nationalgeographic.com/ngm/resources/0304.**

Ma

The Rise of Mammals

Adapting, Evolving, Surviving

Maternity in Flesh and Stone. A mother-to-be cradles a remnant of the past, the fossilized *Eomaia scansoria*, or "dawn mother." At 125 million years old, the newly unearthed climbing mammal was on the evolutionary line to placental reproduction and is 50 million years older than scientists expected it to be. Such fossil finds continue to yield hints about how mammals arose, adapted, and thrived. Beyond bones, the latest genetic technologies are now providing fresh answers to long-held queries about our evolutionary path.

By Rick Gore Photographs by Robert Clark Art by Kennis and Kennis

MEGACHOERUS

MEGATHERIUM (TOP), EPIGAULUS (BOTTOM)

Ghosts of Mammals Past

HYRACOTHERIUM

PLATYBELODON (ABOVE), *RODHOCETUS* (BOTTOM); *HIPPOSIDEROS* (CENTER RIGHT)

More fact than fiction, these wild characters followed transitional Jurassic period animals that sported mammalian skull traits and reptilian teeth (composite at top left). Over tens of millions of years warthog-like ungulates, horned gophers, giant sloths, four-toed horses, elephant relatives with toothed shovels for jaws, legged whales, and leaf-nosed bats made their debuts and, ultimately, their exits. "In its day, each was highly successful," says paleontologist Michael Benton of the University of Bristol. "Their forms made sense at the time. Their diversity of size, of habit, of diet is mind-boggling." A more familiar design, humans (bones at top right) mark the present. Says Benton, "We are part of the assemblage. If you want a full picture of the evolutionary potential of life, you have to go way back from here."

SOURCES: FARISH A. JENKINS, JR., AND F. REX PARRINGTON, ROYAL SOCIETY (EARLY MAMMAL SKELETON); BERNARD VANDERMEERSCH (HUMAN SKELETON)

The Fantastic Four

Just how closely are the world's mammals related? New genetic data propel this complex discussion, turning established beliefs about family ties upside down. *Molecular biologists* studying mitochondrial and nuclear DNA of living animals are using statistical techniques to group placental mammals with their closest kin. The result is a new quartet of superorders: Afrotheria includes elephants, aardvarks, and hyraxes; Xenarthra has sloths, armadillos,

and anteaters; Laurasiatheria covers seals, cats, whales, and horses; and Euarchontoglires includes primates, rodents, and rabbits. Some of these gene-based superorders are at odds with groupings formed from fossil analyses (pages 14-15) and have sparked scientific debates—but also partnerships. In practical terms, finer genetic maps will likely lead to new and better treatments for both veterinary and human disease.

It's All Relative

The fossil head and painted bones of *Hadrocodium wui* point to our past. Though just a spoonful, the mouselike creature (opposite), found recently in China, had traits that humans now have—middle-ear bones detached from the jaw and a large braincase—195 million years ago. That's much earlier than scientists had believed such key innovations emerged.

From the top of Shifting Sands dune in the Serengeti Plain of Africa a million mammals are in motion. Wildebeests. Zebras. Gazelles. The plain is black with them. It is wildebeest calving season, and many of those giant bearded antelope have newborns trailing them. Others walk with the distended bellies of imminent birth. From a distance the movement seems a serene and constant march toward the southeast, where recent rains have made pastures greener. But a closer look reveals details of high drama.

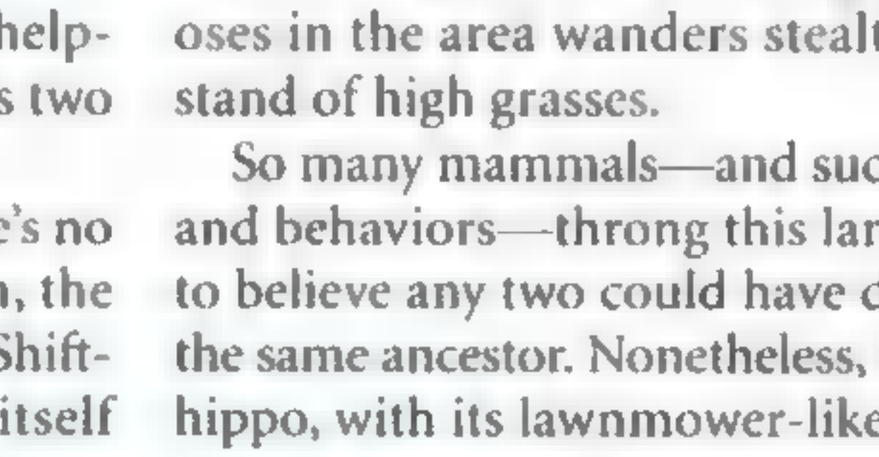
A young Grant's gazelle suddenly dashes between the clusters of wildebeests, followed closely by its mother. A hyena races in pursuit. The mother slows and moves evasively to distract the hungry predator. But the inexperienced fawn makes a panicky turn. Within moments it falls victim to the jaws of the hyena. A few yards away, ears twitching, the mother stands helpless. Then, as if in frustration, she charges two jackals on the sidelines of the kill.

"She must be feeling emotion, but there's no way to prove it," says Patricia Moehlman, the wildlife biologist who has brought me to Shifting Sands, a 12-foot-high dune that is itself slowly migrating across the plain. Continues Moehlman, "She's a mother. Her brain may not work like ours, but I think there's pain. I think there's fear. And certainly stress. We feel connected to her because she's a fellow mammal."

Local Masai women regard the dune as a sacred fertility site. Moehlman calls it "a place of pilgrimage." Indeed, no place on Earth offers a more spectacular abundance of our fur-bearing, breast-feeding brethren, especially when the wildebeests are on the march. But the wildebeests are only part of the scene. Myriad mammal species graze, gallop, prowl, and wallow in this part of Africa.

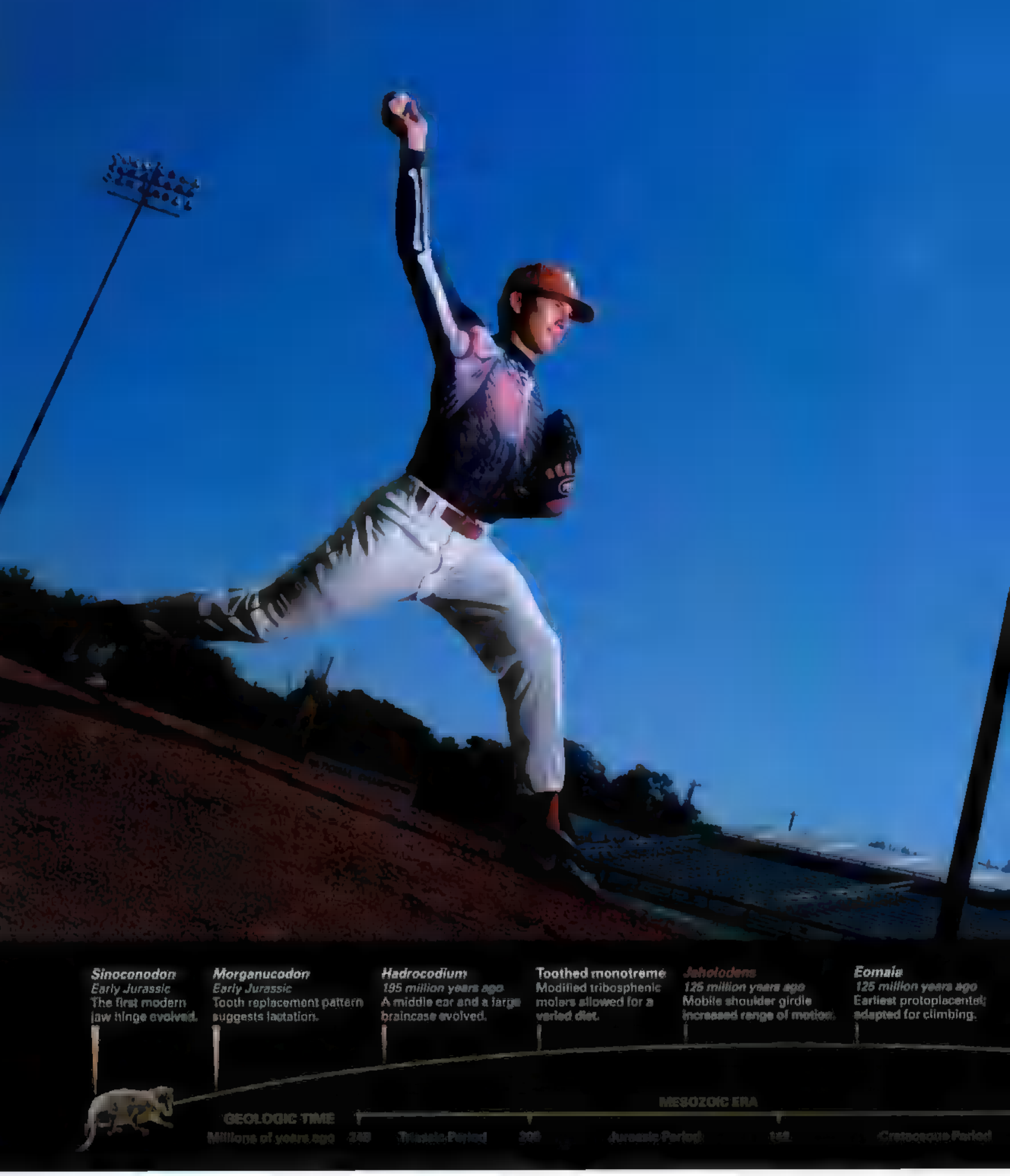
In the nearby Ngorongoro Crater a mother hippopotamus nuzzles her pink newborn in a muddy pond, while a pair of lions leisurely copulate along the roadside. In a grove of acacia trees a group of giraffes, members of a family of mammals that until 20 million years ago were small forest dwellers, nibble at the top branches. A few miles away elephants—which scientists are just now realizing may come from one of the oldest of the modern mammalian lineages—lumber toward a midday bath in a rain-swollen stream. Quick-witted vervet monkeys dash down from the trees to steal food through the open door of a tourist van. Meanwhile, one of the few surviving black rhinoceroses in the area wanders stealthily through a stand of high grasses.

So many mammals—and such varied shapes and behaviors—throng this land that it's hard to believe any two could have descended from the same ancestor. Nonetheless, the amphibious hippo, with its lawnmower-like diet of up to a hundred pounds of grass a night, shares a common lineage with the three-inch-long naked mole rat—a subterranean, tuber-chomping hot dog with teeth, which lives like a termite in large colonies dominated by a queen.



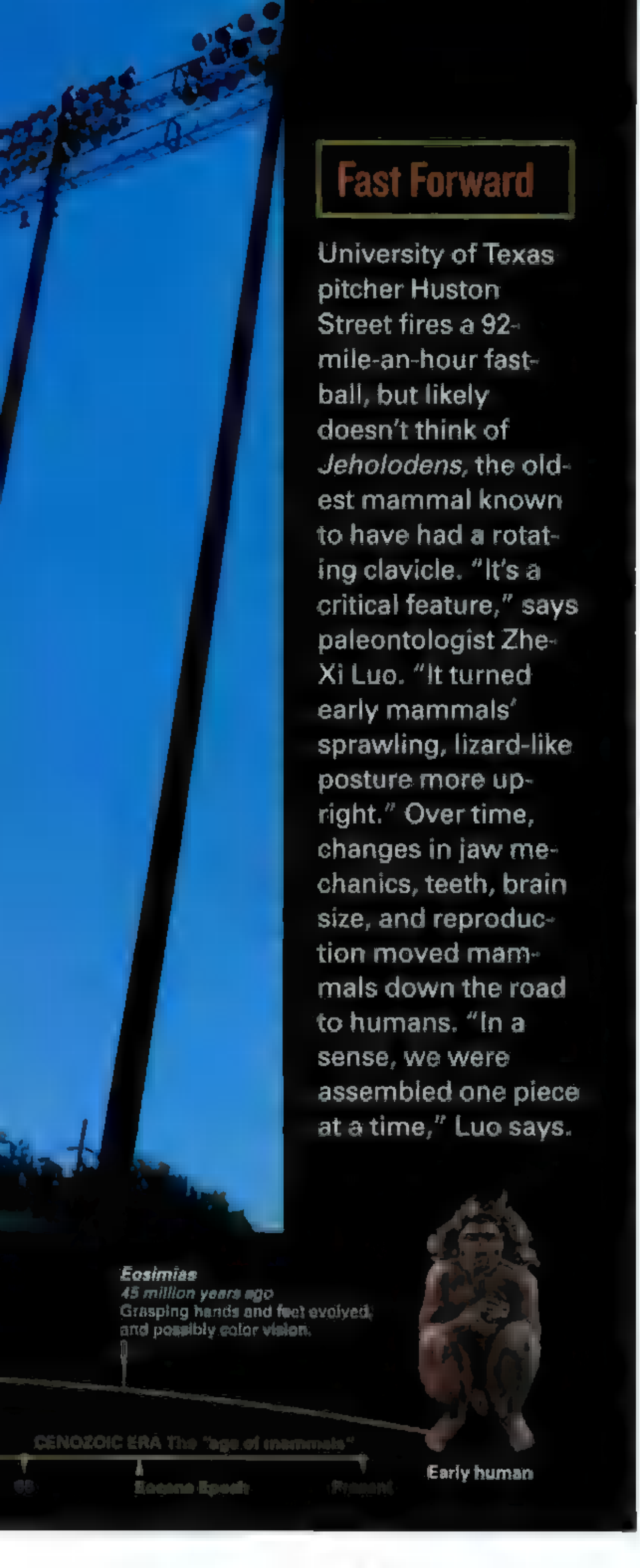
Deep in their bones, all mammals are related. The earliest known mammals were the morganucodontids, tiny shrew-size creatures that lived in the shadows of the dinosaurs 210 million years ago. They were one of several different mammal lineages that emerged around that time. All living mammals today, including us, descend from the one line that survived. During the next 145 million years of evolution, the dominance of dinosaurs ensured that our distant

FOSSIL BODY (OPPOSITE) PAINTED BY MARK KLINGLER, CARNEGIE MUSEUM OF NATURAL HISTORY; MODEL (ABOVE) BY BRIAN COOLEY AND MARY ANN WILSON



mammalian ancestors remained no larger than a cat. But when a catastrophic asteroid or comet —maybe a few comets, as some scientists are now arguing—finished off the dinosaurs 65 million years ago, mammals got the most important evolutionary opportunity they would ever have. With dinosaurs gone, mammals could exploit the planet's resources themselves. Within a few million years of the impact the fossil record shows an explosion in mammalian diversity. (For another theory on the dinosaurs' disappearance, see this issue's Who Knew?)

How did those little creatures transform into not only the hippo and the mole rat but also today's vast panorama of mammals with fur, hooves, and fangs, as well as others that swim hairless through deep oceans—or ride, like me, in a Land Rover across this grassland?



Only humans can ask that question, or hope to answer it. We are, in a sense, the ultimate mammals. To be sure, we share defining traits with the first mammals—traits that were evolving even as the morganucodontids scrambled for food among the dinosaurs: We are warm-blooded. We have specialized jaws, whose hinges came together early in our evolution to create the ear bones that let us hear better than other animals. We have complex teeth that let us grind and chew our food so that we get more nutrition out of it. We have hair. We are superb mothers whom evolution has supplied with physical adaptations—such as breasts and placental birth—that give mammalian young an important head start. We humans are among the most recent to evolve, and we use our big mammalian brains to reason and solve problems and struggle for goals beyond our basic needs. We ask about our past and wonder what it might tell us about the future.

From scratching around in the dirt to deciphering DNA—how did we get from there to here?

That question has never had an easy answer, but today new fossil discoveries and important new tools are illuminating our distant past more clearly than ever before. Less than half a century ago, trying to understand mammalian evolution was like exploring the universe with a primitive telescope. But now high-speed analysis of genetic evidence, painstaking reconstruction of past climates and continental movements, and dogged work with often minuscule bones are creating insights that are challenging some cherished assumptions.

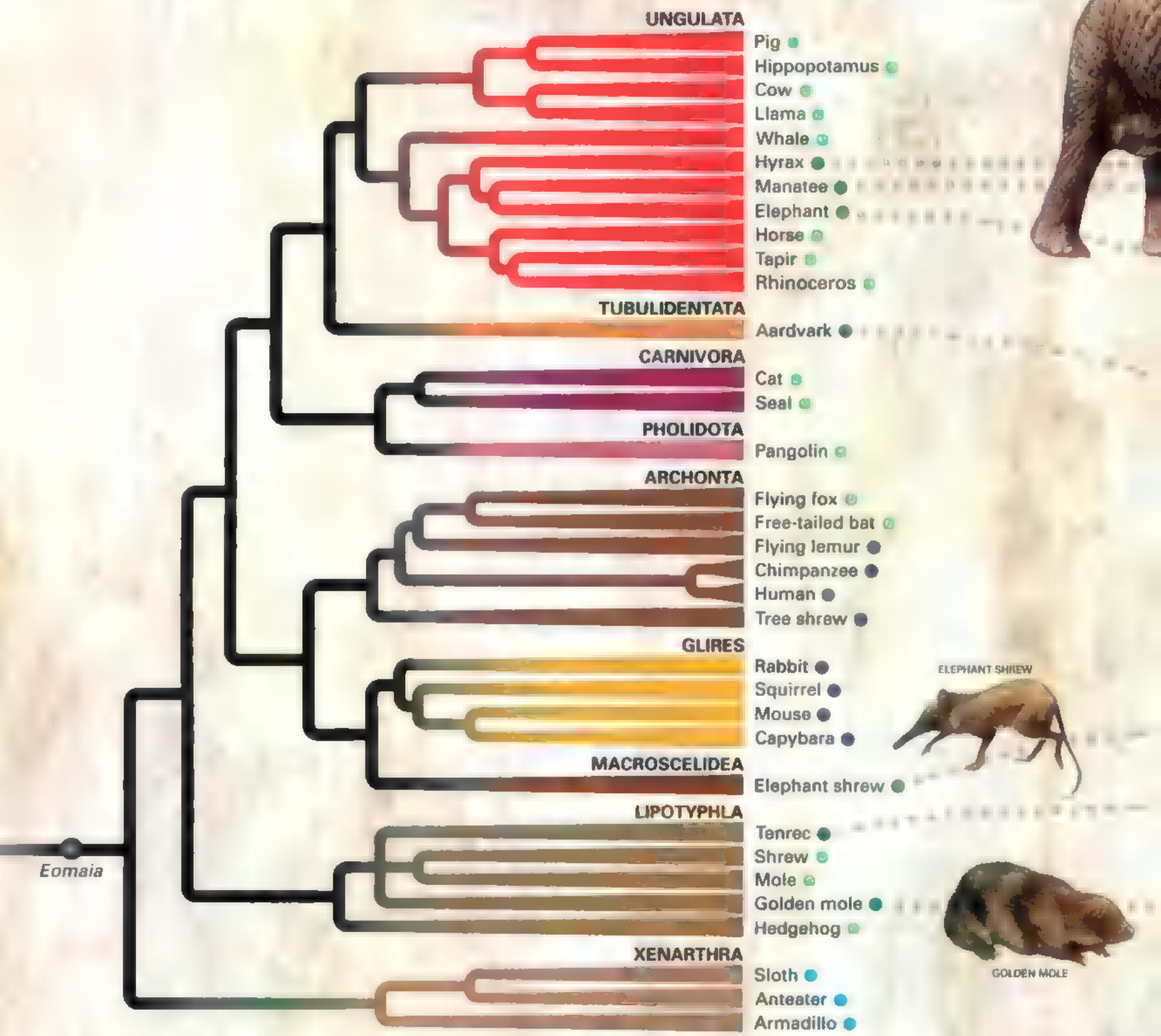
In the late 1960s, evidence emerged that the world's landmasses were once assembled into one great continent, called Pangaea. Around 225 million years ago Pangaea began to split into a northern continent, called Laurasia, and its southern counterpart, Gondwana. Each continent carried its own cargo of animals. Based on the known fossil record, scientists believed that the ancestors of mammals alive today emerged in the north, and then migrated south, all the way to Antarctica and Australia, as land bridges episodically developed between the continents.

André Wyss, a paleontologist at the University of California, Santa Barbara, says that's known as the "Sherwin-Williams model of evolution," a reference to the paint company logo that shows paint dripping over a globe from north to south.

Recently paleontologists have dug deeper into the fossil record of southern continents. They are finding evidence of advanced mammals far older than any known in the north,

SINOCONODON AND EARLY HUMAN BY KENNIS AND KENNIS

Is the Truth in the Bones



COMBINING FORCES

Though DNA is giving rise to new family trees, fossils still make history. They tell scientists how extinct animals looked, lived, and where they came from. For example, we think that the genetically determined superorders Afrotheria and Xenarthra originated on the supercontinent Gondwana because of where their fossils were found and where their descendants live today. Fossil finds also tell us that ungulates, aquatics, and insect-eaters evolved in both the Northern and Southern Hemispheres. Still, fossils can't reveal precise relationships the way DNA can. And techniques are still improving. Until recently, geneticists couldn't compare long-extinct species because their DNA is also long gone. Now a method of sequencing the amino acids in osteocalcin, a protein in bone that may stick around for hundreds of thousands of years after animals die, is providing a new tool for probing the past. But protein extraction is damaging to bones, meaning that some hard-won artifacts will be sacrificed for the cause.

ART BY ROBERT HYNES (ANIMALS), PORTIA SLOAN (FAMILY TREES), AND TARA DALTON. MAP BY CHRISTOPHER R. SCOTESE, PALEOMAP PROJECT, AND NG MAPS.
SOURCES: FU-GUO ROBERT LIU AND MICHAEL MIYAMOTO, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF FLORIDA (MORPHOLOGICAL TREE); MARK S. SPRINGER, DEPARTMENT OF BIOLOGY, UNIVERSITY OF CALIFORNIA, RIVERSIDE (GENETIC TREE AND DISTANCES)

. . . or in the Genes?

From fossil and morphological analyses, paleontologists came up with the traditional family tree at far left, beginning with the protoplacental *Eomaia*. Below is the geneticists' version of the same chart, in spiral form (line lengths suggest genetic distances). Dotted lines show one example of where the two disciplines part ways: Animals from four distinct branches of the traditional tree fall into one genetic category, Afrotheria. "With just bones, it can be hard to see the connections," says evolutionary biologist Fu-Guo Robert Liu.

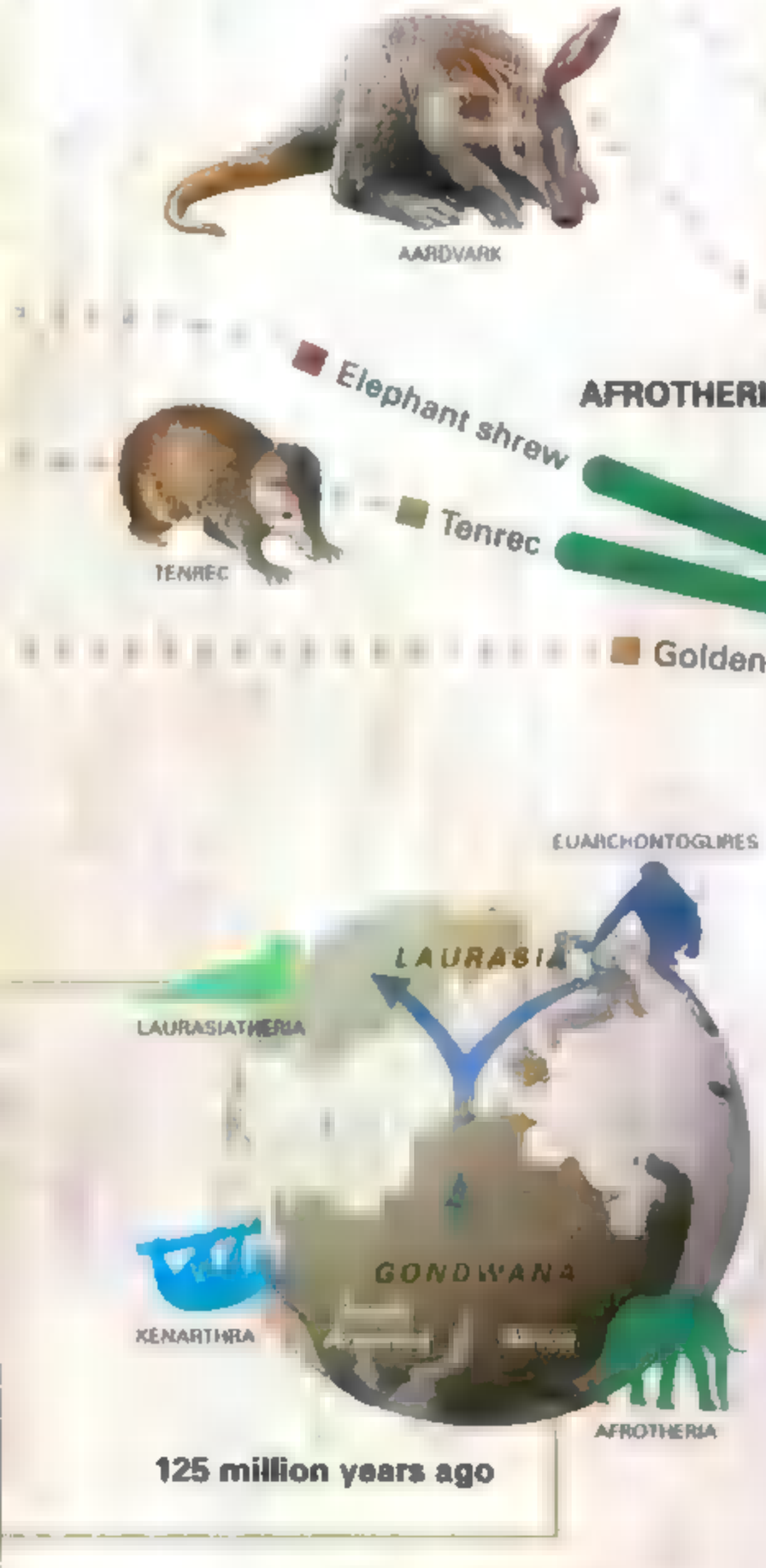
AFRICAN ELEPHANT

ROCK HYRAX

MANATEE

AARDVARK

TENREC



■ Relationship according to anatomy

Evidence that mammals evolved in the Southern Hemisphere came in the form of jawbones and teeth.

perhaps turning the Sherwin-Williams world upside down.

On another front, geneticists comparing the genes of living mammals have found that certain groups thought to be very distant cousins—hippos and whales, say—are in fact next of kin. They have also found evidence that mammals began to diversify into today's 18 living orders much earlier than the fossil record shows. Fossils suggest that most modern groups appeared around 60 million years ago, after the dinosaurs were gone. Molecular data suggest they actually began diversifying about 100 million years ago.

"It's been a complete upheaval," says Mark Springer, an evolutionary geneticist at the University of California, Riverside. "We've come up with a very different family tree for mammals."

Many paleontologists angrily reject the DNA findings, arguing there must be something wrong with the molecular clocks the geneticists use to date their findings. The geneticists counter that paleontologists just haven't found the right fossils yet.

Scientists who trust the fossils and those who look to the genes agree on at least one thing: Mammals were starting to come into their own around the time of the morganucodontids. Their tiny jawbones—about an inch long—show just how different the mammalian form was from the giant reptile world.

Their jawbones were beginning to fuse into one piece. "This is very different from reptile jaws, which are made up of several bones," says paleontologist Rich Cifelli of the Sam Noble Oklahoma Museum of Natural History. "Modern mammals' bones migrated backward to become the small bones of the middle ear. That's why mammals hear so much better than reptiles."

The separation of the jaw and the ear bones allowed the skulls of later mammals to expand sideways and backward—enabling mammals to develop bigger brains. The teeth of the morganucodontids were another important innovation that later mammals would improve upon. The upper and lower molars of morganucodontid jawbones interlocked, letting them slice their food into pieces. That released more calories and nutrients.

"Reptiles don't cut up their food," says Cifelli. "They grab and gulp. But these little guys were so active they had to get every calorie they could out of what they ate. The more they could process their food in their mouths, the more energy it gave them."

The jawbone also indicates that the morganucodontids had another important mammalian trait—they drank mother's milk. Researchers can infer that morganucodontids nurtured their young with mammary glands that produced milk because, like all mammals today, this animal had only one set of permanent teeth—as its jawbones show. This is in contrast to the growth pattern of reptiles, non-milk-drinkers, which must continually replace teeth their entire lives.

Scientists believe mammary glands began as sweat glands at the bases of hairs. Both sweat glands and mammary glands produce water, salts, and proteins, all of which a newborn needs to survive.

The duck-billed platypus of Australia gives us a glimpse of how those primitive mammary glands worked. The platypus and the spiny anteater are the only surviving examples of a mammalian subgroup called monotremes.

"The platypus female doesn't have nipples," explains Peter Temple-Smith, a platypus specialist at the Melbourne Zoo. "Rather, there is a region where milk ducts come together and

Multi-tasking Molar

It slices, it grinds, it pulverizes. The revolutionary tribosphenic molar (right, from an opossum) may have evolved independently in the Northern and Southern Hemispheres 167 million years ago. It led to improved digestion and nutrient absorption in early mammals. Diets expanded, opening new niches for mammals among the dinosaurs.

Southern Living

Which came first? The egg. Monotremes, or egg-laying mammals like the spiny anteater *Zaglossus,* bottom right—a snouted worm-eater—preceded placental mammals. So might have marsupials like Australia's rhino-size *Zygomaturus,* right, and lionlike *Thylacoleo,* far right. Marsupials, which carry their developing young in a pouch, once thrived worldwide. But for reasons still in debate, placentals ended up on northern continents while marsupials and monotremes took over the south—eventually enjoying geographic isolation there. Climate change and human hunters later drove many to extinction. Still, says paleontologist Steve Wroe of the University of Sydney, "Australia isn't intrinsically barren ground for placentals. Now everything from cats to camels runs riot."

> They "must have been frenetic little animals. Kind of caffeinated. They probably ate all the time."

secrete milk onto hairs. The young then lick or suck the milk off the hairs."

Nipples, which concentrate milk ducts, probably emerged with the branch of mammals we know as marsupials—a group that includes kangaroos, koalas, and opossums. "The advantage of nipples is that they give the young something to hold on to," says Temple-Smith. "The marsupial mother can therefore continue to roam about and feed freely, carrying her baby wherever she goes in her pouch."

Back on the Serengeti, we see again how mammals emphasize maternal care. A newborn wildebeest stands between the legs of its mother, its skin still wet from birth. Suddenly the air fills with the cries of vultures. They descend and with their fierce beaks begin to tear into the placenta lying a few yards away. The mother wildebeest jerks her head. Their arrival has announced to every scavenger for miles around that there is fresh young meat here, and she urges her calf into as fast a gallop as its wobbly legs can manage.

"She's being a good mother," says Moehlman, the wildlife biologist. "If you aren't a good mom, your lineage dies out. That's what being a mammal is all about."

The bloody wildebeest placenta, which the scavenging birds fight over so aggressively, illustrates the physical investment that advanced mammalian mothers make in their young. Metabolically speaking, the placenta is very expensive for the mother to maintain. Yet it is invaluable. It not only nourishes the fetus in the womb; it also isolates the developing fetus from the mother's immune system. Otherwise, her immune cells would attack the fetus as a foreign object—after all, half its genes come from the father.

Reptiles and birds avoid immune system attack by surrounding the fetus in an eggshell and moving it out of the body. Monotremes such as the platypus still lay eggs. And marsupials solve the immune problem by delivering their embryos early.

Recent DNA studies suggest placental mammals began to diverge from marsupials as early as 175 million years ago. Thus far, the fossil record has not shown this, perhaps because paleontologists trying to date the split have only little teeth and jawbones to work with. The major differences between placentals and marsupials lie in the reproductive tract—which doesn't leave much fossil evidence. But the spectacularly complete new fossil of a protoplacental species found in China's Liaoning Province has given a concrete example that strengthens DNA researchers' claims that placentals began evolving much earlier than previously thought.

"This is the mother of all placental mammals," says Zhe-Xi Luo, a paleontologist at the Carnegie Museum of Natural History in Pittsburgh, proudly presenting a fossil of what resembles a pressed mouse with a long snout. It is so well preserved that some of its fur remains visible. "We call it *Eomaia*, which means 'dawn mother' in Greek."

Luo and his colleagues estimate the fossil's age at 125 million years and have found anatomic markers that suggest that *Eomaia*, while not fully placental, was well on its way to becoming so. That placental development was so far along 125 million years ago makes it easier for paleontologists to accept the genetic evidence that says the first protoplacentals began to evolve 50 million years earlier.

Eomaia's mousy appearance makes it a pretty modest prize by today's mammal standards, but the little creature was the leading edge of a wave of mammalian evolution that had begun with the morganucodontids. *Eomaia*'s placental progeny represented a huge leap, opening up evolutionary options that marsupials' pouch approach constrained. For instance, marsupials develop their forelimbs early in order to climb into the pouch. But placentals' extra time in the womb lets specializations such as the bat's wing and the seal's flipper evolve. The placenta also transports nutrients much more efficiently than milk ducts do. As a result, placental babies grow faster in utero and are more mature when they leave the womb.

For those reasons, most scientists regard

the pouch strategy as archaic, and perhaps inferior, pointing out that placental mammals have dominated most of the world for the past 65 million years.

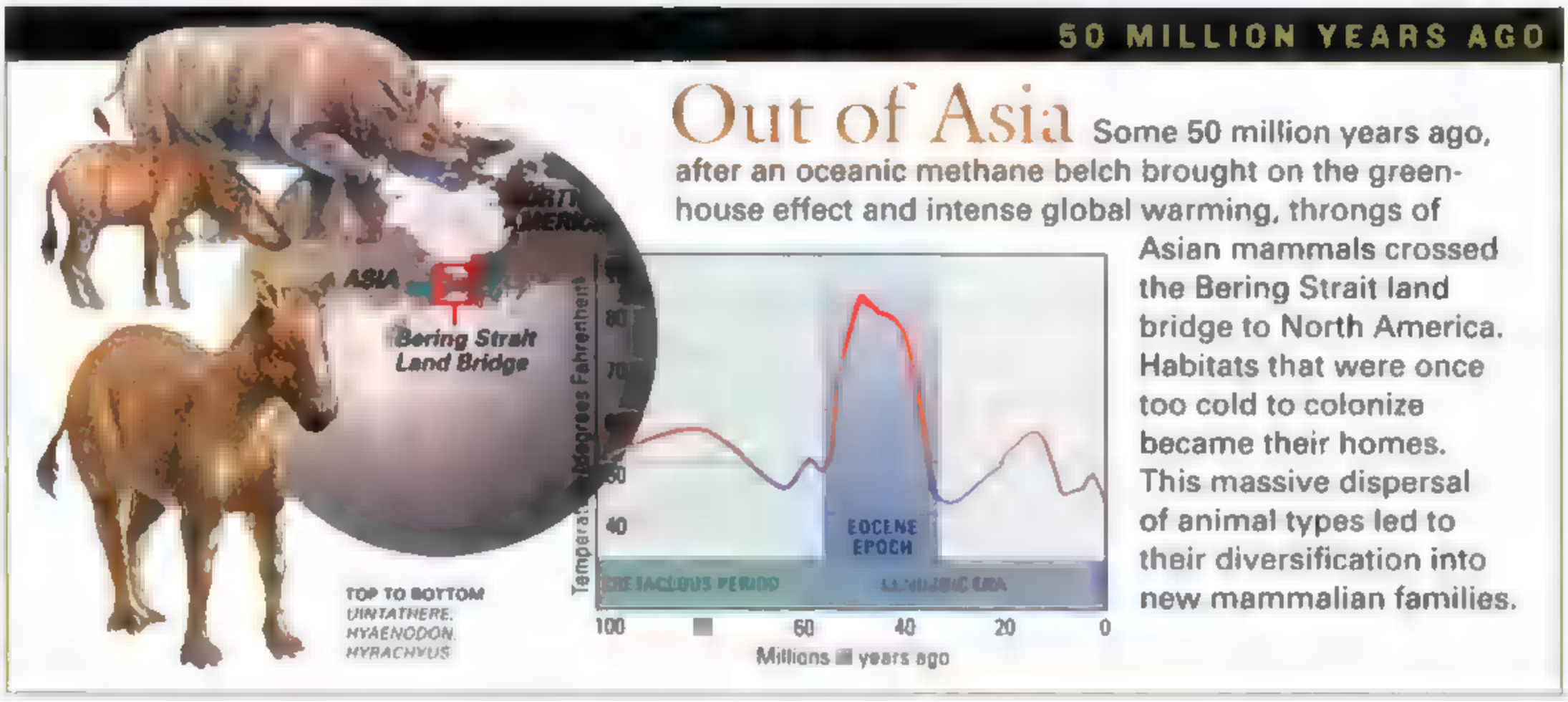
However, there are some dissenters. Marilyn Renfree, a marsupial specialist at the University of Melbourne, says that biologically speaking, "marsupials are every bit as good as other mammals—and in some ways superior." Marsupials have lower metabolic rates and can therefore survive in a broader range of conditions. Mike Archer, director of the Australian Museum, also believes that the pouch has its advantages. "For marsupials there is such a thing as being a little bit pregnant," he says. After having two eggs fertilized, a kangaroo mother may have only one egg fully develop. Should food or water become scarce and the firstborn infant die, the embryo-in-reserve can implant itself after conditions improve. In an arid land such as Australia, these conditional pregnancies can be the best strategy.

But marsupials remain much less common than other mammals. Opossums and other marsupials exist in North and South America, but Australia is the only continent where marsupials—and monotremes—still rule.

Kangaroos, koalas, platypuses, and wombats: Why does Australia retain these supposedly antiquated mammals? According to the Sherwin-Williams model, marsupials, advanced mammals themselves 100 million years ago, migrated into Gondwana ahead of placentals. They simply got on board the Antarctic-Australian landmass before it broke away from the rest of Gondwana. Placentals arrived too late—the Australian ship had already sailed.

That theory made a lot of sense until the late 1990s, when some revealing fossils began turning up in various parts of the old Gondwana—Patagonia, Madagascar, and Australia.

The new evidence, once again, came in the form of jawbones and teeth—a particular type known as tribosphenic molars. Such teeth work like a mortar and pestle, a further improvement on the slicing teeth of earlier mammals.



The ancestor of marsupials and placentals had tribosphenic teeth. Thus the discovery in the Southern Hemisphere of tribosphenic teeth as old as 167 million years, or 25 million years older than any found in the north, complicates the north-south model. Some explain the presence of these southern tribosphenic teeth by saying they must have developed independently in both hemispheres. Others say the innovation was too intricate to have evolved twice and that mammals must have evolved in the south, with subsequent generations moving north.

"It's good to remember that the evidence is still slim," says Oklahoma's Rich Cifelli. "I like to say that anyone who really stands up strongly for either theory is either nuts or thinks too highly of himself."

The tribosphenic controversy gets even deeper in Australia, where the husband-and-wife team of Tom Rich of the Museum of Victoria and Pat Vickers-Rich of Monash University have turned up three different mammals with

ART BY ROBERT HYNES (ANIMALS) AND TARA DALTON. MAP BY CHRISTOPHER M. SCOTESE AND NG MAPS. SOURCE FOR CLIMATE GRAPH: MICHAEL J. NOVACEK, AMERICAN MUSEUM OF NATURAL HISTORY, AND C. M. JANIS, B. BURCHARDT, J. A. WOLFE, R. A. ASKIN AND R. A. SPICER

Chilled Out

Out of place and time, a 55-million-year-old *Sabalites* palm—now fossilized in a sediment plate—is propped up in the snow on Wyoming's Fossil Butte. In its day such fronds lined a warm, shallow lake where crocodiles eyed wading birds and four-toed horses came to drink. But as the climate cooled, the lake vanished and the forests retreated; snow and sagebrush now reign in these parts.

tribosphenic teeth dating back 110 million years. The Riches say that these mammals weren't simply on the way to becoming placental, they were placental—something like hedgehogs, in fact.

Opponents of the Riches' theory argue that placentals—and certainly not the relatively advanced hedgehogs—were not supposed to be anywhere near Australia so long ago. *Eomaia*, that early forerunner of placentals, lived in Asia. If the Riches are right, we have to rethink how placentals traveled from Asia to the Southern Hemisphere. Rather than traveling down the Americas, *Eomaia* may have found an island-hopping shortcut to Australia. Or perhaps placentals were widespread much earlier than we think now, and there's just no record of them. They could even have originated in Gondwana and spread out from there. Placentals, suggest the Riches, might even have become extinct with the dinosaurs in Australia, making room for the marsupials to move in later.

Rich himself concedes, "Most radical ideas are wrong. It's wise to be wary of them—especially when they are your own."

Even more radical to many paleontologists has been the marriage of plate tectonics evidence and the placental family tree proposed by evolutionary geneticist Mark Springer and his colleagues (pages 14-15). Springer is part of a new generation of researchers who examine the strands of an animal's DNA rather than scraping dirt from fossils at a dig. These molecular biologists read the sequences of genes in a living animal's DNA like an evolutionary history book. The scientists can then determine how closely these animals are related genetically and how long ago their ancestors diverged.

Troubling as it is to many paleontologists, Springer's reading of mammals' genetic history fits remarkably well with what geologists now know about the breaking up and subsequent motion of ancient continents. The oldest group of living placental mammals, according to Springer and his colleagues, arose in Africa just before the continent finished breaking away from the rest of Gondwana around 110 million years ago. Springer calls these animals afrotheres. They include elephants, aardvarks, manatees, and hyraxes. When Africa floated off, it carried

these animals away to evolve on their own for tens of millions of years.

The fossil record for Africa from this period is almost blank. Nevertheless, Emmanuel Gheerbrant, a researcher for the National Center for Scientific Research in France, speculates that Africa "must have been a laboratory for some very peculiar animals."

One species Gheerbrant has discovered from this period in Africa is the oldest and most primitive known member of the elephant group, the proboscideans. The 55-million-year-old fossil of *Phosphatherium escuilliei* was discovered in Morocco. It was the size of a fox, and although it lacked a trunk, it had many dental and cranial features strikingly similar to modern elephants. Paleontologists had long thought elephants were one of the younger modern groups, evolving from ungulates that originated in Asia. But Gheerbrant's fossil, like the genetic evidence, suggests that proboscideans are in fact one of the oldest of the modern ungulate mammals.

One of the few fossil-rich regions in Africa—the Faiyûm Depression of Egypt—has not only these early elephants *(Continued on page 28)*

Last Stand

Great legs linked strongly to its spine suited it for land. Heavy ribs and a retracted nasal opening meant it also went to sea. *Pezosiren portelli* (reconstructed skeleton below)—the 50-million-year-old ancestor of modern manatees—walked like a hippopotamus and swam like an otter before becoming fully aquatic. It lost its hind legs, and its front limbs turned into paddles. Though of different genetic stock, whales evolved in parallel, taking similar steps to reach the water.

Growing to Extremes

Sometimes it pays to stretch the limits. Bulk benefited Asia's *Indricotherium*, the largest known land mammal ever (weighing the equivalent of several modern elephants). Its size let it browse tall trees and discouraged enemies. But size also brought its demise: When climate change turned this giant's forest environment grassy, it couldn't stoop to graze and became extinct. Also now gone, *Elephas*, or pygmy elephants —knee-high to their modern counterparts—became small statured living on Mediterranean islands, perhaps because foraging areas were limited. Dwarfism also has its perks, including reduced food needs, easy hiding, and faster reproduction. There's no consensus on what causes size extremes, though land area, seasonality, resources, and predatory threat are likely all part of the answer.

Mammals suddenly found themselves in a world without large carnivores. Restraints were off.

but also a strange assortment of hyraxes. Today hyraxes resemble guinea pigs. But 35 million years ago hyraxes took many forms. Some were the size of rhinoceroses; others had long legs like gazelles.

Most mammals on the African ark began to disappear around 20 million years ago, after Africa came into contact with the rest of the world again. But Africa wasn't the only ark. An ancient seaway split South America from Eurasia and North America for millions of years, and South America became home to what geneticist Springer calls xenarthrans, another group of placental mammals. South America's fossil record during its isolation is far better than Africa's, and includes such xenarthrans as sloths, armadillos, and anteaters.

Springer's data, in other words, indicate that the most recent common ancestor of placental mammals is Gondwanan. Contrary to more than a century of northern chauvinism, the northern continents have the youngest placental mammals. One group, the laurasiatheres, includes seals, cows, horses, whales, and hedgehogs. The other group, euarchontoglires, includes rodents, tree shrews, monkeys, and humans.

These genetic findings reveal more than simply which came first. They also redefine relationships among placental mammals. For one, anatomists have always assumed that bats were in the same superorder as tree shrews, flying lemurs, and primates. But genetic data place bats with pigs, cows, cats, horses, and whales.

The data further show that these superorders of living mammals started to diversify much earlier than the fossil record suggests. What gets fossilized is a record of an animal's shape. But geneticists contend that genes in an organism's mitochondria, the parts of a cell that are used to trace and date lineages, can be evolving rapidly without changing what would be left behind in the fossil record.

"An animal's shape may be heavily affected by its environment," says Úlfur Árnason, a geneticist at Sweden's University of Lund. "Crocodiles haven't changed much physically in 250 million years, yet they have a high rate of change in their mitochondrial DNA. Birds have a slow rate, yet they can evolve physically very rapidly."

However surprising the claims of geneticists seem at first, paleontologists and DNA researchers are finding that their theories can be complementary. Some stunning new fossils have confirmed a previously controversial DNA finding about whales. Most paleontologists long believed that whales and dolphins—or cetaceans—descended from an extinct line of carnivorous mammals that for unknown reasons became aquatic between 50 and 45 million years ago.

At the time of these fossils' discovery, molecular biologists were maintaining that new DNA work indicated the cetaceans were actually aligned closely with artiodactyls, an order that includes even-toed ungulates such as pigs, camels, deer, and hippopotamuses.

Paleontologists first dismissed this unlikely connection because nothing in the fossil record supported it. Then in September 2001 two teams of fossil hunters published finds that backed up the claims of the biologists. A group led by Hans Thewissen of Northeastern Ohio Universities College of Medicine found two species of the earliest known whales in 50-million-year-old deposits in Pakistan. Both had ear bones unique to whales, but the legs and anklebones of artiodactyls. "The first whales, it turns out, were fully terrestrial and good runners," Thewissen says.

Almost simultaneously, a group from the University of Michigan led by Philip Gingerich announced similar fossils from Pakistan that

Fruits of Their Labor

It was the perfect partnership. Megabeasts like the giant sloth (right) may have dispersed big-seeded plants back in the late Pleistocene, some 15,000 years ago. A seed hidden in slippery fruit is easily swallowed whole and later passed, nicely fertilized. These big-seed sowers are now extinct, so humans do the job with trowel or plow.

had the same dual traits. The evolutionary transition among major groups of mammals is rarely illustrated so clearly. And no other discoveries have linked fossils to DNA findings with such precision.

Until 65 million years ago dinosaurs dominated the land. The oceans swarmed with huge sharks and voracious marine reptiles. The dinosaurs and other large predators occupied the richest and most obvious evolutionary niches, keeping mammals at the margins.

Then an event occurred whose scale is still hard to comprehend. An object six miles across crashed near the present-day Yucatán Peninsula, punching out a crater 110 miles across. That impact may have been one of many over the next several hundred thousand years, each adding to the destruction. But the damage done by the Yucatán impact alone is impressive: Tsunamis 500 feet high battered North America. The temperature reached 500 degrees in parts of the world.

"Everything big bit it," says Kirk Johnson of the Denver Museum of Nature & Science. "The key to survival was to be small." Mammals fit that profile. They suddenly found themselves in a world without large carnivores. Restraints were off. Within 270,000 years they were diversifying and growing bigger.

Still, the majority of mammals didn't get much larger than a pig until the Eocene epoch, which began about 55 million years ago. Then a rapid increase in global temperature encouraged the spread of forests around the world—even near both Poles. This abundance of rich vegetation opened yet more ecological niches for mammals to exploit. Mammal diversity soared. One of the newcomers in the fossil record was our own order, the primates.

The earliest primates belonged to the lemur branch. Today lemurs are confined to the island of Madagascar, where one species made it from Africa perhaps 50 million years ago, probably on rafts of storm-tossed debris.

A few million years later, more advanced primates appear in the fossil record of eastern Asia. These higher primates are anthropoids—monkeys, apes, and humans. Chris Beard, a specialist in primate origins at the Carnegie Museum of Natural History, has unearthed in China what may be the earliest known example, called *Eosimias*. These creatures evolved in the mid-Eocene as the world was cooling and concentrated in the midlatitudes where forests remained lush.

Beard says they "must have been frenetic little animals. Kind of caffeinated. They probably ate all the time. When you are that small, you have to. They probably lived in troops and maybe never left the tree they were born in." Despite its primitive anatomy, *Eosimias* had already adopted the monkeylike habit of walking along the tops of branches rather than leaping from tree to tree like earlier primates.

About 34 million years ago smarter, bigger, and more aggressive monkeys evolved. Fossils from the Faiyúm Depression, where Elwyn Simons of Duke University has led a dig since 1961, reveal how anthropoids were changing. *Catopithecus*, one of many anthropoids his team has uncovered, has a skull the size of a small monkey's, a relatively flat face, and a bony enclosure at the rear of its eye sockets. It is the first anthropoid to show the same arrangement of teeth humans have—two incisors, one canine, two premolars, and three molars—leading Simons to argue, "This is the first chapter of human history."

At the start of the long Miocene epoch—23.5 million to 5.3 million years ago—yet another major climate change occurred. The world was warming again and more seasonal climate patterns may have emerged. At higher latitudes, forests gradually gave way in many places to grassland meadows and savannas. Because grass is abrasive, some mammals developed new dentition. Horses, for instance, emerged as little leaf-eaters in the forests but later developed molars that are much better adapted to eating grass. Horses' crowns extend into the jawbones. As the crown gets ground down, new crown will emerge from the jaw to replace it.

Early in the Miocene, Africa's long isolation ended when it and Arabia came back into contact with Eurasia. That's when the ancestors of many mammals we think of as native to Africa arrived there. First came the ancestors of antelope, cats, giraffes, and rhinos. Later, around ten million years ago, North American mammals—camels, horses, and dogs—began to arrive. Almost every animal that roams the Serengeti today is a relative newcomer to the continent.

Africa gave back as well. Apes moved into Eurasia and flourished. Elephants and their relatives spread across the globe, reaching as far as the tip of Patagonia.

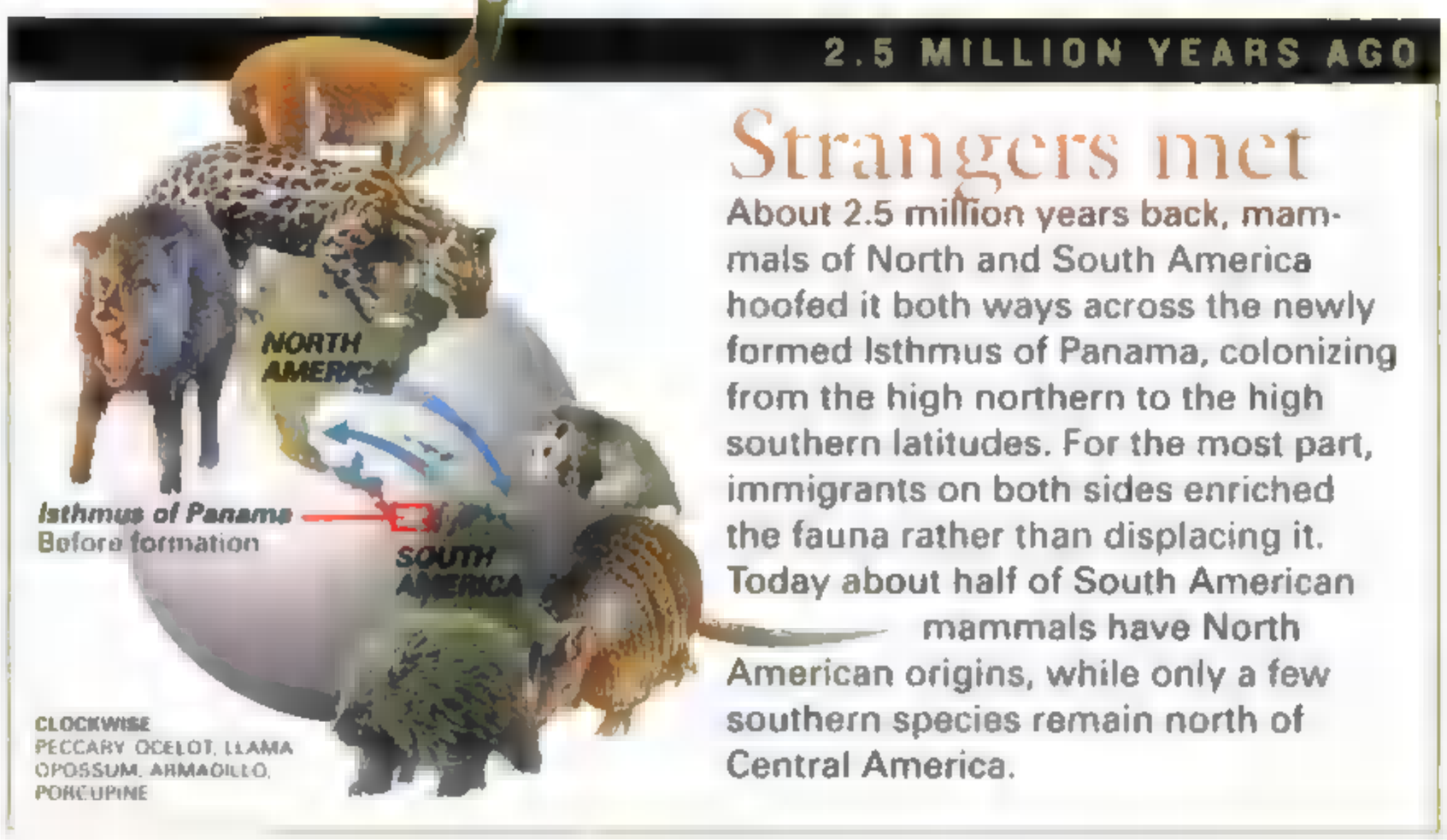
But geology and climate changed the world once again for mammals as the Miocene drew to a close. The Earth grew colder and drier still. Ice caps formed in the Arctic. The Sahara began taking over North Africa, and savannas spread across much of the continent.

The changing climate restricted the range of the primates to the equatorial zone. The surviving apes became larger and more specialized. Then, around seven million years ago, at least one offshoot of the African apes began walking on two legs.

As that bipedal ape evolved into what would become us, other mammals came and went. Most had to adapt to yet another global climate change about 2.5 million years ago, triggered in part by the formation of the Isthmus of Panama. Its formation blocked east-west ocean circulation and encouraged the Gulf Stream to grow stronger. As the Gulf Stream pumped more warm water closer to the North Pole, precipitation increased. Heavy snows became glaciers two miles thick, which advanced and retreated in a series of more than 20 ice ages. Because big bodies retain heat better, many mammals, such as the woolly mammoth, grew larger. Even in the temperate zones of Australia, animals became immense. Australia was soon home to big meat-eating kangaroos, wombat-like creatures the size of trucks, and a marsupial lion twice as big as a leopard.

"It was a kick-ass big predator," says paleontologist Steve Wroe of the University of Sydney, as he admires a foot-long fossil skull of a marsupial lion from 40,000 years ago. "These big shearing teeth make it more highly adapted as a carnivore than any other known mammal." The teeth, explains Wroe, are "for butchery only. The animal would starve to death in a fruit and veggie shop."

Those big mammals, such as the marsupial lion and the killer kangaroo, disappeared between 100,000 and 20,000 years ago. Few controversies rage more fiercely in paleontology than why the megafauna vanished—not just in Australia but also in North America, where mammoths, horses, camels, and dozens of other large Ice Age mammals all vanished by about 11,000 years ago. Many scientists cite climate change. Others say it was humans, arguing that newly arrived *Homo sapiens* killed off the giants with their spears.



Strangers met

About 2.5 million years back, mammals of North and South America hoofed it both ways across the newly formed Isthmus of Panama, colonizing from the high northern to the high southern latitudes. For the most part, immigrants on both sides enriched the fauna rather than displacing it. Today about half of South American mammals have North American origins, while only a few southern species remain north of Central America.

We humans may or may not have killed off the giant mammals of the Ice Age. But we are unquestionably threatening innumerable species today, as we expand relentlessly into ever more of their habitats. Signs of this encroachment appear all around the world. Manatees in Florida chopped up by boat propellers. Rhinos in the Ngorongoro Crater poached. Vast rain forests in Southeast Asia obliterated. All this done by the most intelligent of mammals. Evolution has given us this gift of intelligence, but are we too smart for our own good? If somehow we could rewind time to the dawn of anthropoids, what different path could we have gone down?

One answer lies some 5,000 miles from the Serengeti's vibrant mammalian spectacle, in the rain forests of Indonesia, Borneo, and the Philippines. There lives *(Continued on page 36)*

ART BY ROBERT HYNES (ANIMALS) AND TARA DALTON; MAP BY CHRISTOPHER R. SCOTESE AND NG MAPS

Perfect Teeth

"If there's a good mode of life," says Michael Benton, "evolution will hone different groups to fill it." That's known as convergence. Take the saber-tooth trait. The catlike *Barbourofelis,* right, of Eurasia and North America got its daggers for downing big, thick-skinned prey. Filling the same niche in South America, the marsupial *Thylacosmilus,* bottom right, evolved similar weapons and lost teeth it didn't use. "These guys were specialized to kill fast, eat their fill, and go," says Steve Wroe. In contrast, *Megistotherium,* top, had more generalized teeth—to pierce, crush, and scrape bones clean—though it was distinct in another way. "It was bloody big," says Wroe. But neither bite nor bulk saves specialists when their habitat changes faster than they can adjust. Wroe adds, "They were first to bite the dust."

ZEBRA

BAT

INSETS 28 PERCENT OF ACTUAL SIZE

DOLPHIN

PANDA, LEFT HAND

DOLPHIN X-RAY, MOTE MARINE LABORATORY AND AQUARIUM, SARASOTA, FLORIDA; ZEBRA X-RAY, PAUL ANIOS; OTHER X-RAYS BY SMITHSONIAN NATIONAL ZOOLOGICAL PARK, WASHINGTON, D.C.

KODIAK BEAR, LEFT HAND

ORANGUTAN AND HUMAN (ACTUAL SIZE)

A Show of Hands

You've got to hand it to mammals: They're nothing if not adaptable. While all these modern-day paws are derived from the five-digit form of a common ancestor, each has gone its own way. The boreal orangutan's robust palm and long digits give it swing (though humans' more mobile thumb gave us the evolutionary edge). Pandas evolved a "thumb" of their own—an oversize wristbone—to grasp bamboo, while a bat wing has light, thin finger bones for wing support and a short claw for clinging. A zebra's hoof is reduced to a single "finger" to elongate the limb for rapid running. The dolphin's flattened hand is a bone-filled fin used for steering and balance. And claws equip the Kodiak bear to dig, scratch, and skewer.

the tarsier, which the Carnegie Museum's Beard cites as an example of the primate road not taken. "Tarsiers are pretty weird," says Beard. "They can turn their heads 270 degrees. They're the primates' version of an owl. But they're the nearest living relatives of higher primates."

Tarsiers share a common ancestor with all anthropoids. We know this because like all higher primates, tarsiers lack a tapetum lucidum—the reflective layer in the eyes of nocturnal animals. The tapetum lucidum is critical to vision in low light levels and is what makes the eyes of night creatures glow when a flashlight shines on them.

Unlike most of their anthropoid relatives, tarsiers went back to a nocturnal lifestyle at some point and had to compensate by evolving enormous, spooky eyes. Shine a flashlight in a lemur's eyes at night, and they'll glow back at you. A tarsier's won't.

For humans, tarsiers represent what might have been. But because of us, today they're hard to find. Hunting, development, and the destruction of the rain forests have constricted the tarsiers' habitat.

In Borneo, where tarsiers are considered bad luck, few villagers worry about that. "If I see a tarsier, I go home," says a villager in Kampung Duras in Sarawak. Another local, Lemon Ales, agrees. "They frighten people because of their big eyes. Also, they may leap on you and bite."

Other villagers regard the tarsier as totems, because the small agile creatures sometimes are seen in rice paddies holding on to the rice stems, as if guarding them.

Lemon and I head into the forest at twilight. The world looked like this in the Eocene, when primates were evolving. The forest is full of the same kinds of fruit-bearing trees that helped primates thrive in the vast forests then emerging around the world. The heavy air seems to press moisture into my skin, and my pores fight back with gushes of sweat. With flashlights we stumble on for several hours in the dark. But the tarsiers never show up. Or maybe they do: The locals warn that if the creatures don't move, you won't see them.

The Singapore zoo has tried to make sure its patrons won't be similarly disappointed. Its tarsiers are behind a glass wall in a simulated forest. "Only six zoos in the world have tarsiers," says C. S. Menon, an animal management officer. "Usually they stress out and die in captivity."

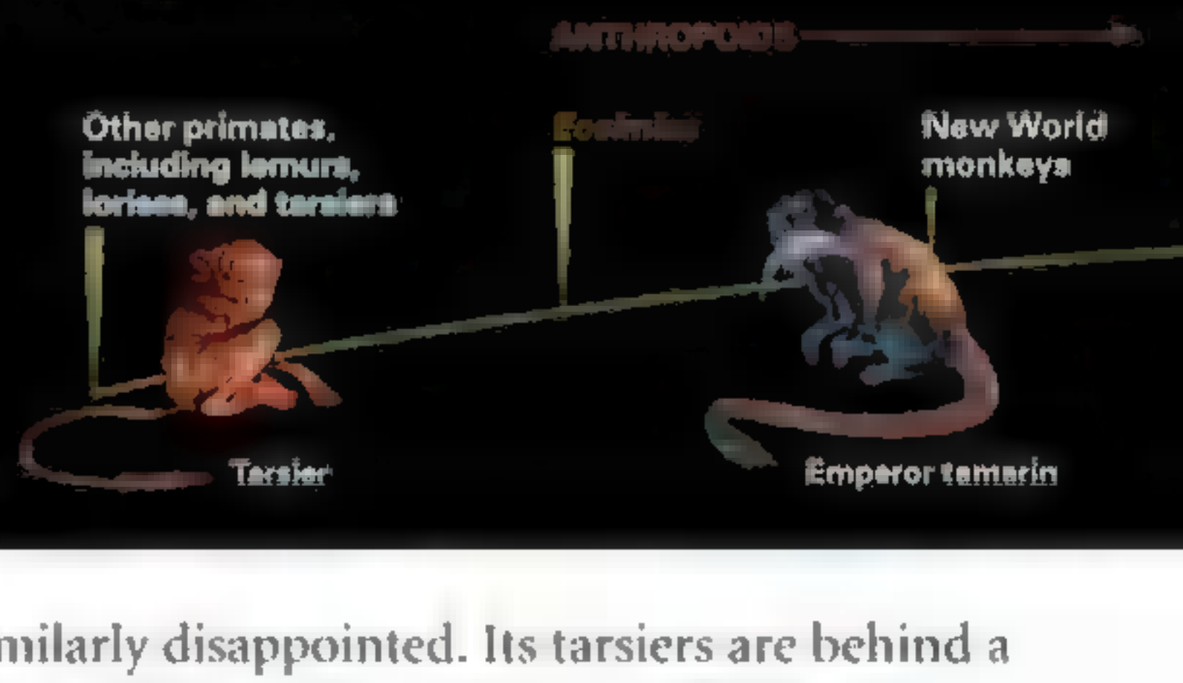
Eager, often pushy, visitors chatter in languages ranging from Dutch to Hindi to Japanese while waiting to board zoo trams that will take them to see what few can now see in the wild at night.

WEBSITE EXCLUSIVE

How do you get a good look at an animal that's extinct? Visit our website to see mammal modeling and human ingenuity at **nationalgeographic.com/ngm/0304**.

Out on a Limb

That its anklebones and teeth were found in China has jaw-dropping implications. *Eosimias* (model at right) may be the oldest known anthropoid, or higher primate—suggesting our own origins are Asian, not African. Controversial? Absolutely, says paleontologist Chris Beard: "It would change the whole debate of where and when we evolved." Despite decades of study, the lines from tarsier to Tarzan remain unclear. Says Beard, "Each time a fossil is found that fills an evolutionary gap, two more gaps are blasted wide open."



Many get off the tram, pause for a moment at the tarsier exhibit, and move on. That's because even here, under the best nighttime viewing conditions—the simulated light of a full moon—tarsiers are difficult to spot. I try to be patient.

Finally, like lightning, one flashes out of nowhere to grasp a cricket with both hands and land gracefully on a slender branch. It sits upright, munching and rotating its little head in an improbably wide arc. You can't look into the big eyes of our distant cousin without feeling awed by the distance we have traveled away from each other. Our intelligence may pose grave dangers to the world's wildlife and to ourselves, but it also lets us feel wonder. And concern. The jury's still out on where that will take us.

Then, faster than a moth's flutter, the tarsier is gone. □

COSMIAS MODEL BY BRIAN COOLEY AND MARY ANN WILSON; ANIMALS BY ROBERT HYNES; EARLY HUMAN BY KENNIS AND KENNIS

DEPTH CHARGERS

Below Dubai's parched plateaus and craggy peaks a team of daring scientists rappels into some of the world's most spectacular caves, including Majlis al Jinn, the Meeting Place of the Spirits. What they find might someday lure adventure seekers to this wealthy Arabian kingdom's vast underworld.

BY GREGORY CROUCH • PHOTOGRAPHS BY STEPHEN L. ALVAREZ

ON THE LINE "Some caves feel friendly," says team leader Louise Hose. But don't be fooled by the bright and spacious interior of Majlis al Jinn. A 518-foot drop awaits those who venture in.

WHERE'S NANCY?
Majlis al Jinn—one of the world's largest known cave chambers—dwarfs biologist Nancy Pistole.

AS I STAND OUTSIDE THE SUPERMARKET IN MUSCAT, THE AUGUST HEAT TWISTS INSIDE MY CHEST. WE'VE JUST ARRIVED IN THE CAPITAL OF OMAN, AND THE BLINDING GLARE MAKES ME SQUINT BEHIND MY SUNGLASSES. I GLANCE AT LOUISE HOSE, A TOUGH-MINDED GEOLOGIST WHO HAS PLUMBED THE DEPTHS OF NORTH AMERICA'S LARGEST SUBTERRANEAN CAVES.

SOCIETY GRANT

This Expeditions Council project was supported by your Society membership.

Strawberry blond hair spills out from beneath her yellow baseball cap. She wears shades dark enough to hide her eyes. But I don't need to see her steely gaze—forged by years of field research in dusty, far-flung locales—to know that my discomfort isn't going to arouse her sympathy.

"We've got a lot to do," Louise declares, marching into the market to buy sundries for our expedition. "So drink plenty of water."

Louise is an odd mix of no-nonsense academic and gonzo caver. On campus at Chapman University in Orange, California, she's known as an enthusiastic geology teacher. Outside the classroom she's earned a reputation as a hard-core adventurer—confident, decisive, even abrasive. An unlikely mission brings Louise to Oman: The government, aware of her caving credentials, has invited her to examine the country's spectacular limestone caves. Her research team will systematically survey the caves using satellite-based global positioning technology to pinpoint cave

HOLEY GROUND **A helicopter whisked Louise Hose (above) and her team to the 5,000-foot-high Selma Plateau. Getting tourists up here to visit the caves would be a logistical feat. "Omanis could build a tramway from the coast, then dig a tunnel to the Majlis al Jinn cave," says Louise. "But it wouldn't be cheap."**

entrances, lasers to calculate interior volumes, and air-monitoring sniffers to check for harmful levels of gases, such as carbon dioxide. The team's biologists will gather and analyze water samples and inventory the flora and fauna both above and below the surface.

Someday Oman's lucrative oil reserves will be pumped dry, so the government is encouraging economic diversification of all kinds—from copper mines to cookie factories. The caves, it hopes, could be developed into a tourist attraction like New Mexico's Carlsbad Caverns National Park, which generates more than 30 million dollars a year.

Following management guidelines used by the U.S. National Park Service Cave Resources Program, Louise's project will collect detailed geological, biological, cultural, and paleontological data, and she'll generate a 3-D map of the largest cave. The idea of underground tourism might seem crazy, but she plans to give it a thorough testing. Are the caves too dangerous, unstable, or their ecosystems too fragile to sustain tourism? Or could they support a new national park, attracting sought-after tourist dollars to Oman?

After a whirl of meetings with officials in Muscat, Louise and fellow caver Nancy Pistole take photographer Stephen Alvarez, his assistant Ben Cadell, and me to the airport. We board a jet for Dhofar, a coastal region in the south, where Louise plans to start her reconnaissance.

The sky is perfectly clear as we soar over the brown and yellow deserts of central Oman, but a thick layer of clouds obscures our descent into Salalah, Dhofar's largest city with 157,000 inhabitants. From June to September the monsoon blows a steady drizzle in from the Indian Ocean, making Dhofar the mildest place on the Arabian Peninsula.

It is still raining the next morning as Ben drives us east toward the Jabal Samhan, one of the limestone massifs that line the coast. Louise wants to examine Tawi Attair, the Well of the Birds, a huge sinkhole within the massif. Twenty miles east of Salalah the mountains squeeze

FLUID STATE

Taab Spring attracts weary travelers from afar. But life here is unpredictable. Rockslides forced a family of goat herders to abandon their oasis-side home, now just a skeleton of stone.

UNTIL RECENTLY WEAPONS WERE A NECESSITY HERE, WHERE RAIDS BLAZED THROUGH THE DESERTS.

toward the sea, and we turn away from the coast onto a road that rises into the highlands. Walls of stacked limestone blocks bound the fields, where cattle and camels graze on natural terraces —abundant herds that embody the wealth of these mountain tribesmen, the Jabalis. The landscape is emerald green. "My God," says Ben, a tall, lanky man with pale blue eyes and long scraggly hair who hails from Linlithgow, Scotland. "Lose the camels and this looks like home."

We turn off the pavement and park in a cow pasture. Thick wet grass soaks us to mid-thigh as we push toward the pit's edge. Ahead of us the ground vanishes—Tawi Attair, a 690-foot hole that formed when a cave roof collapsed long ago. Inside, it's big enough to fit a 50-story skyscraper. Great curtains of green foliage festoon the walls. Hundreds of swifts, rock doves, and even a few raptors pinwheel inside. Their coos and twitters well up to the lip. Suddenly the idea of tourists stepping out of a bus to admire this monstrous hole doesn't seem so far-fetched.

"All right," Louise growls as she shrugs off her battered cave pack. "Let's drop this pit."

Nancy anchors the rope to several nylon slings that she's threaded through Swiss cheese–like holes in the limestone bedrock. As she works, two men from a nearby farmhouse scramble over to watch. Salim Said Ali al Amri, 20, and his younger cousin Ahmed Mohammed Suheil al Amri are barefoot, wrapped in traditional purple robes. Salim sports a "No Fear" T-shirt, and Ahmed carries binoculars and a .303 Enfield rifle. Until very recently weapons were a necessity in this area, where tribal raids and counterraids blazed through the deserts and mountains.

Salim and Ahmed watch transfixed as Nancy rappels into the pit. "Jabali ladies don't do anything like that," remarks Salim. When Louise hooks to the rope and begins to lower herself into the void, Ahmed shoulders the .303 and fires off a round to celebrate her courage. Ben and I recoil in surprise and scramble for cover. Louise, suspended over the immense drop, nearly suffers heart failure.

Soon my turn comes, and I ease over the edge. No avoiding it: I have to look down to wrap the rope over my ankle to help control my descent. Far below, I vaguely make out tangled mats of greenery. Ten minutes and 330 feet later I drop into a thicket. Above, birds flutter across

GOING TO EXTREMES **Annual monsoons soak the limestone cliffs at Wadi Darbat, triggering a three-month tide of green. Drive inland, toward the Empty Quarter, and the color soon ebbs. "How often do we get a good rain?" muses local guide Mabrook Massin (opposite). "About once every 20 years."**

the gray circle of sky. I realize that I haven't heard a single birdsong on the way down. My fear has shut out their sound.

I find Nancy and Louise standing in front of what looks like the entrance to a mine. We turn on our headlamps and march into the dark passage. After a hundred feet we come to a murky pool that appears to be knee-deep. "Look out," Nancy warns, as I wade in. "Cave water can be deeper than it looks." Too late: I stumble and fall in over my head. Nancy's guffaw and Louise's hard laugh thunder through the chamber like heavy construction.

"I'll join you," Louise says. "I'd like to see the far side of the pool."

Louise's body vanishes beneath obsidian black water until all that's left is a floating head. She has been exploring caves for 31 years, including two descents in Mexico more than 3,280 feet below the surface (equivalent to 1,000 meters—the gold standard for cavers). But she still can't suppress her childlike delight in being underground. We swim for 60 or 70 yards before the water ends at a rock dam. It is a good seat—four feet wide—but when we peer over the other side, we discover a cliff that drops 50 feet to a mound of boulders. "Guess this is as far as we go," Louise says. "I don't think there's anything down there for the casual tourist. But I bet they'd come to see the sinkhole itself."

We swim to Nancy, then ascend the rope to join Stephen and Ben up top. We take off our wet and muddy harnesses, load our packs, and slog back to the truck for the return drive to Salalah.

For the next two weeks, while we explore caves in the nearby mountains, Louise seems optimistic about the potential for tourism. So far, her scientific team has turned up little evidence to suggest the caves might be dangerous. A few had high levels of carbon dioxide, but others appeared safe—no contaminated pools, no crumbling interiors that might unexpectedly collapse.

"Oman has world-class features," she says. "With minor improvements, they could be great attractions. Signs, overlooks, and better

IN THE PITS
Serenaded by a choir of sparrows, raptors, and rock doves, Nancy Pistole climbs out of Tawi Attair, or Wall of the Birds—a colossal 690-foot sinkhole.

STICKING AROUND **Ahmed Mohammed Suheil al Amri, a Jabali tribesman, lives in Tawi Attair, near the sinkhole. Before they had modern-day wells, locals dropped to the pit's bottom to fetch water during the dry season. Now they come to gather honey—and to marvel at women cavers who clearly know the ropes.**

roads might do the trick." But even with these amenities, would enough people come to support the cave-tourism industry as the Omanis hope? By the time Louise finishes the first phase of her project and heads home for the fall semester at Chapman, it's still too soon to tell.

A NEW CAST OF CHARACTERS accompanies Louise when she returns to Oman five months later: biologist Doug Soroka; Matt Oliphant, Alan Cressler, and Paul Aughey, three experienced cavers; and Louise's student from Chapman, Katri Laukkannen. Nancy Pistole, Stephen Alvarez, and I complete the team.

Louise's goal is to examine the biggest caves in the Eastern Hajar, a range that rises precipitously from the Gulf of Oman to 7,300-foot elevations. The Selma Plateau conceals five caverns, each with an initial entrance drop of 300 feet or more.

It's cold on the bleak plateau. We pitch base camp under a stand of thorny trees on a field of fist-size rocks. Scrubby plants stir in the winter wind. A few hours after we arrive the weather clamps down: For the next four days, visibility through the drizzle is seldom more than a hundred feet, and we don't get much done. Louise can't find the entrances to some of the caves, let alone rig them with ropes.

She also worries that a downpour might flood the caves while we're inside. But by the fifth day she decides we've waited long enough, so we hike to Bayn Halayn, or Arch Cave. Doug rappels in first. When I begin my descent into the plunger-shaped drop chamber, he's already disappeared in a passage as big as a subway tunnel. I reach the bottom, switch on my headlamp and walk in. In 150 yards the passage pinches down to a crawlway, and I find Doug on his knees, spying details in the dirt. He's spotted a two-inch creature patrolling the floor.

I slither over and scoop the bug onto my glove. Doug scrapes it into a petri dish. The creature is albino gray-white, and has no apparent eyes. With three long and three short feelers on each end of its twig-like body it tap-tap-taps around the dish like a blind man with a half

SALIM AND AHMED WATCH AS NANCY RAPPELS DOWN: "JABALI LADIES DON'T DO ANYTHING LIKE THAT."

dozen canes. "This might be a real troglobite," Doug says, referring to an animal so adapted to underground cave life that it can't survive on the surface. "It might be an undescribed species, and it might exist only in this one cave system."

When Louise joins us, I leave Doug to his inventory and follow her down the passage, an arduous, bruising undertaking of awkward twists and turns. At nearly 50, Louise claims she's slowing down. But I sure don't see it as I struggle to keep up. Crawling on all fours, I keep banging my head against the ceiling. The walls are covered in a thin film of oozy clay, and Louise catches me examining a cluster of dead leaves rammed into a cranny. "That's what'll happen to you if this cave floods," she warns.

Still concerned about the danger of a sudden rainstorm, Louise cuts short our exploration, and we return to the surface. Back in camp, the team stands shivering around a raging fire with our local helper, 18-year-old Salim Mohammed al Ghadani and his younger brother Said. Soon, their father, Mohammed Rashid al Ghadani, arrives with a load of water he's brought up by donkey on a two-hour climb from the rugged Taab Spring.

Sixty-year-old Mohammed is a thin man with a full beard and watchful eyes below a cream-colored turban. A single tooth protrudes over his lower lip when he smiles. He shakes his head when I comment on the stark beauty of the mountains where he's spent his whole life. "No, no," he snaps. "In winter it is too cold. In summer it is too hot. Nobody would live here if it wasn't for the goats." He has seven sons and three daughters. The girls stay home to tend the goats, which provide just enough extra income to pay for the boys' school supplies. "I have many hopes for my sons," he explains. "But mostly I hope they will be able to find jobs."

BAD WEATHER PUTS THE EXPEDITION way behind schedule. Our trip is slotted between the end of a gulf states economic summit (the Omanis didn't want us in the country while the conference was in session) and Louise's university obligations. With just three weeks to visit six caves on the Selma Plateau and several others in Dhofar, we don't have much time, and everyone is feeling the pressure.

In the morning Louise wakes up grumpy. "Do we need this circus?" she barks about our chatter and music blaring from a boombox. She may be testy, but I'm on edge too, because in about two hours I'll have to make the biggest cave drop of my life. The day before, Matt, Nancy, and Alan rigged the 518-foot initial descent into Majlis al Jinn, or Meeting Place of the Spirits, one of the world's largest chambers.

We shoulder our packs and hike a mile to the cave. Louise and Stephen go down first, disappearing into a natural trench. There's at least ten minutes of silence before I hear Louise give the signal on the radio: "Off rope." My turn has come. I feed the rope through my rappel device and begin to inch slowly over the lip.

The opening becomes a small slit against the sky as I dip below the roof of Majlis al Jinn. The world balloons around me. It feels as if I am suspended under the dome of a colossal cathedral. Sunbeams from two holes in the roof lance the darkness. Except for the blood whooshing through my ears, the cave is utterly silent. Glancing down, I can't make out much detail in the dim light. Then Louise peers up from the bottom to check my progress, and the distant twinkle of her headlamp brings the whole monstrous scale of the cave into perspective. She's just a dark smudge; I'm still 400 feet from the floor.

Several minutes later I touch the bottom, pleased to discover that Louise—despite all her experience exploring caves elsewhere in the world—is as gobsmacked as I am. "This place is huge, and daylit," she says, her face glazed with awe.

Directly beneath each of the two skylights there is a heap of boulders, pebbles, and dust. The floor of the cave gradually slopes down to a mudflat at the chamber's low point. There is

TOURISTS MIGHT WANT TO SEE THE CAVES, BUT IT STILL FEELS LIKE A LONG SHOT.

THE NEXT WAVE **A saltwater blowhole near Salalah draws a crowd. By making inland caves accessible, Omanis hope to show that there's more to explore than just the coast.**

no exit besides the holes in the roof. Small stalactites hang from the ceiling. Coral pipes, rimstone dams, and cave pearls cover the floor. But my eyes keep getting sucked back to the titanic volume of the chamber; nearly two Great Pyramids would fit inside.

Doug joins us, and I follow Louise and him around the cave for a few hours. The more she looks at the massive cave, the more she suspects it was created by acidic groundwater rising up from deep below. Finally I begin the heart-pounding rope climb to the surface, and 40 minutes later I'm sitting next to Louise on a rock shelf overlooking the cave entrance.

"Well, what do you think?" I ask. Could development of these caves provide opportunities for Mohammed Rashid al Ghadani's children?

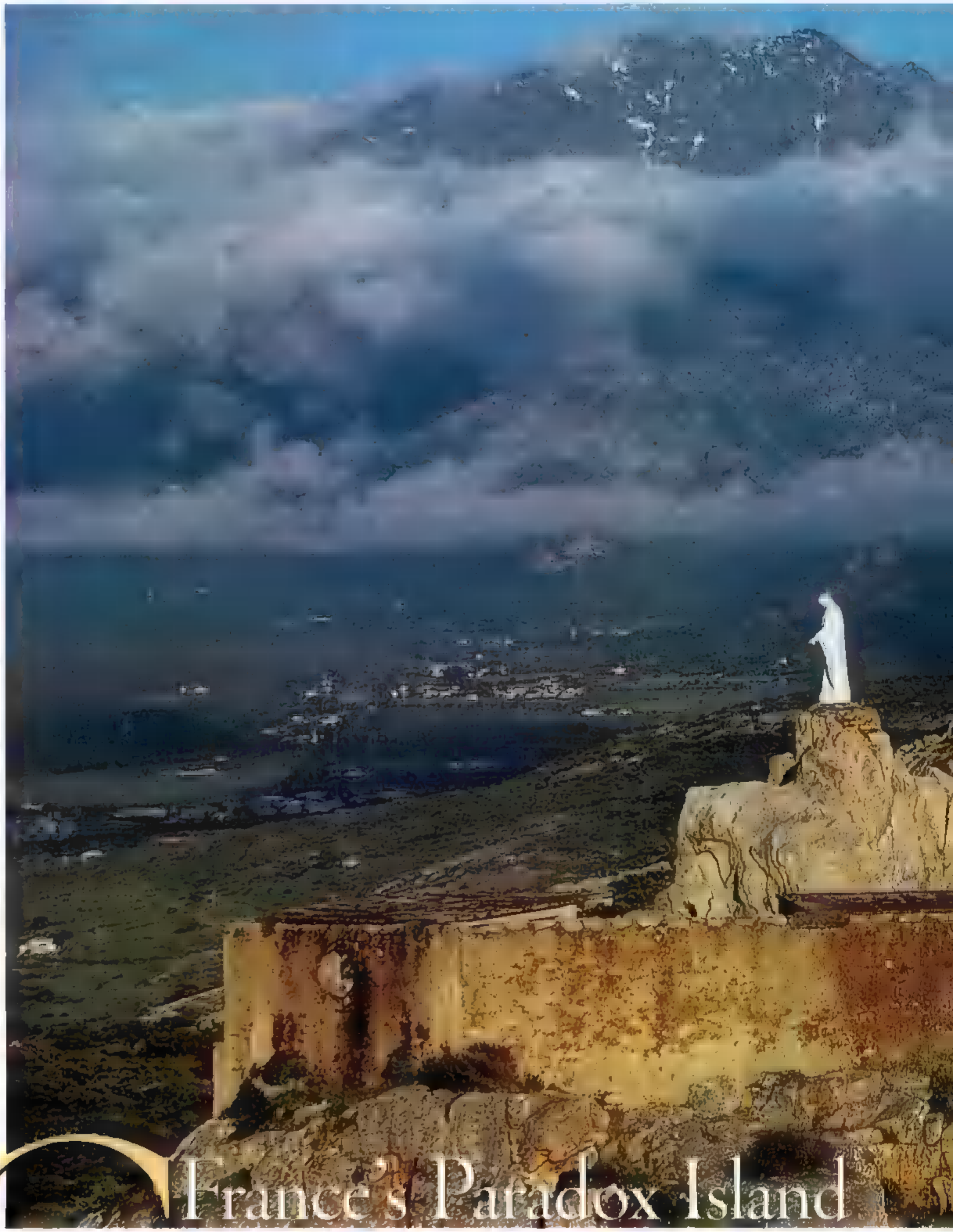
"It's certainly possible," Louise says. A road or a tram could be built. And a shaft could be bored through the bedrock to get visitors into the cave from a neighboring wadi. But the cost would be extraordinary, perhaps prohibitive.

We watch a pair of eagles soar across the sky. Goat tracks crisscross the fields below. Louise has spent her adult life exploring caverns like Majlis al Jinn. To her it seems obvious that others would want to see them too. "Remember, there wasn't much to Carlsbad before the caves were developed, and this is just as amazing," she says.

Maybe true, but the tourist idea still feels like a long shot. Even if it succeeds, decades will pass before ogling day-trippers are rolling up in air-conditioned buses. And if cave tourism never comes to pass, the Omanis won't be left empty-handed: Louise and her team will have completed a new, comprehensive study of the caves, providing the government with detailed physical and environmental information on these rare and spectacular natural wonders. For now, at least, only skilled and resolute adventurers like Louise are likely to explore the subterranean world beneath the barren cobblefields of this spartan landscape. □

WEBSITE EXCLUSIVE

While dangling from a rope 500 feet above the cave floor, you hear gunfire. What would you do? Photographer Stephen Alvarez reports back. And don't miss the film of his descent into one of the world's largest caverns, including spectacular 360° interior views that you can manipulate online at **nationalgeographic.com/ngm/0304.**


France's Paradox Island
CORSICA

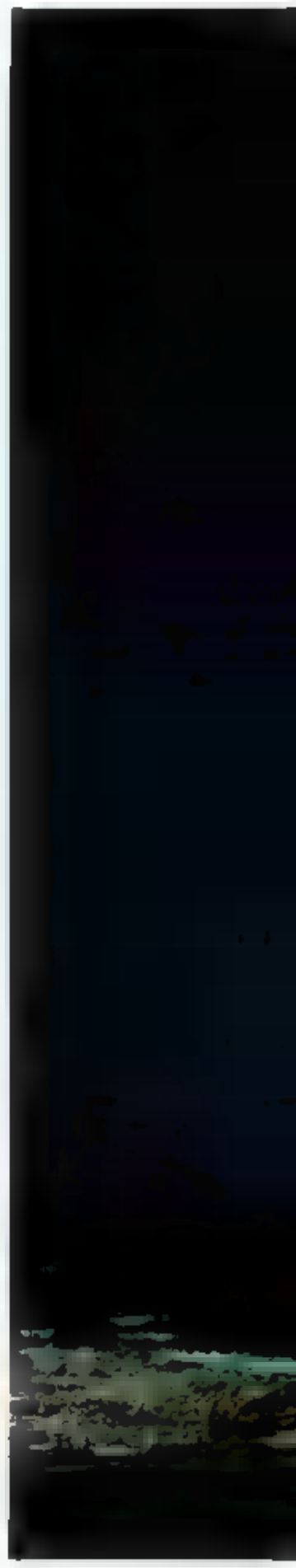
Commanding the high ground, the church of Notre Dame de la Serra offers refuge on the turbulent Mediterranean island of Corsica. Some residents of the French island, known for sun-blessed beauty and endless violence, remain defiantly un-French, pursuing separatist yearnings and a resurgent folk culture.

By PETER ROSS RANGE ❖ *Photographs by* BRUNO BARBEY

Guns and Corsicans go together, even during a Greek Orthodox Holy Week procession in Cargèse, when riflemen fire blanks in celebration. Monsignor Fiorenzo Marchiano, right, tends both Orthodox and Catholic flocks: "When I am with Greeks, I am Greek. When I am with Romans, I am Roman."

The fire this time blazes in Lumio, perhaps set by shepherds to clear brush for their sheep and goats. Firefighters keep busy during the summer dry season: Each year Corsica loses an average of 17,000 acres to wildfire, both natural and man-made—a significant amount on an island of two million acres.

FRANÇOIS SANTONI'S FUNERAL was not what I'd come to Corsica to see. But here it was, the story of Corsica and France all laid out before me, just as Santoni himself was laid out in his home above a sun-hammered mountain hamlet, awaiting burial. After a few days on the island I was already confronting the history and the politics, the vendettas and the violence, the tangled drama of Corsican life and its uneasy relationship with France 234 years after being annexed by the mother country. The island's split culture, part French, part Corsican, and its habit of settling scores by violence, was summed up in a tense village funeral at the end of a high granite valley where, on this day, everything operated according to the rules of classical drama.



We were all playing our roles. Old widows in black stood silently on scrubbed doorsteps. Gnarled men in stiff suits whispered under acacia trees. Prolific families slid silently into the meager August shade of the hard stone church. As though sent from Mediterranean central casting, thick-necked friends of the dead man patrolled the streets, scowling like ravens at journalists and photographers.

And François Santoni, the murdered mafioso, the small-time extortionist, a tough guy in Corsica's clandestine separatist movement, did his part by being, at 41, stone-cold dead. A burly man with an engaging smile, Santoni had met his end three nights before when his enemies in the murky underworld of Corsican nationalism had gunned him down. Revenge, it was said, for two books he'd written about some of his former friends.

The church bell began to toll.

The man pulling the bell rope seemed as ancient as the stones themselves. As he pulled, the village was so still I could hear my own heart beat. Suddenly the bell ringer stopped, and shooting tore the air. *RRRRRRP!* Again *RRRRRRRP!* It was a machine-gun salute from atop the hill, near Santoni's house, to a fallen soldier in Corsica's long-running turf and identity wars. The drama was being played out today just as it had been for decades—even centuries before—in a setting of soaring mountain ridges and fragrant wild shrub called maquis.

The venue would have been perfect for a wedding.

That's the surprise of Corsica. The island leads two lives: one as offshore paradise where couples often come to be married, the other as France's perennial problem child. French vacationers flock to Corsica's mountains and beaches, but the island is also home to a small but violent separatist movement that has kept the political pot boiling for a quarter century.

The paradise part is easy to see. The island is an eruption of granite and magma 105 miles south of France but only 56 miles west of Italy. Its craggy mountains soar to almost 9,000 feet on one coast, while undulating beaches and vineyards line the other. Corsica's interior is a jagged spine ribbed in both directions by a herringbone of valleys so steep and lush that for centuries their inhabitants lived

A sentinel in the sea off Macinaggio forms one link in a chain of 16th-century signal towers built by the Genoese city-state, last in a string of foreign rulers before France claimed Corsica late in the 18th century.

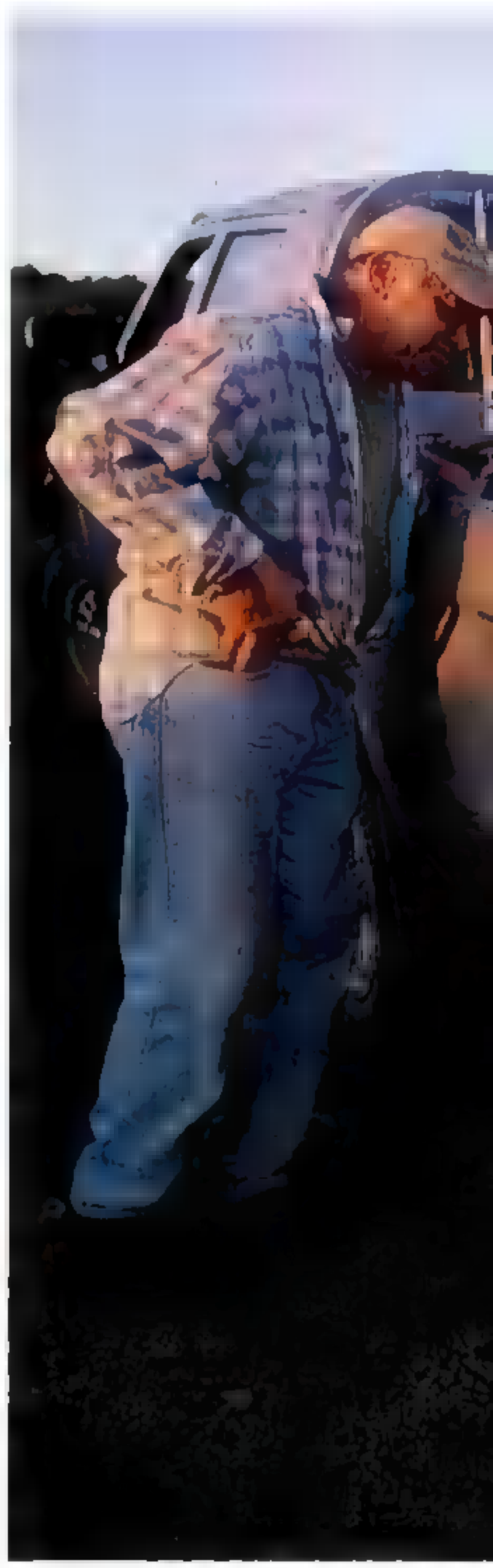
studiously apart, except when one had a multigenerational vendetta against another over the long-forgotten theft of a chicken—or a sidelong glance at a woman. In the chestnut forests of the Castagniccia region, tiny villages and grand buildings cling to mountainsides, eternally poised to repulse the waves of invaders that swept over Corsica for 2,000 years: Greeks, Carthaginians, Romans, Moors, Genoese, and, finally, the French. Beaches, deserts, and alpine forests are layered like the *fromage de brebis* pastry that Corsicans serve to visitors. This diversity in a 115-mile-long outcropping of soil and rock once led an American diplomat, who had a house there, to say, "Corsica is not an island—it's a continent."

And yet the Corsican paradise has a darker side. François Santoni's funeral was its emblem: the latest killing in the internecine battles of an underground independence movement. The *clandestins*, as the secret separatists are known, want a return to the glory days of 1755-1769 when the island enjoyed self-rule under the Corsican national hero, Gen. Pasquale Paoli. They try to achieve an independent Corsica with low-grade violence—midnight bombings of public buildings, blowing up new construction along the beaches, repainting road signs from French into Corsican. Because their movement has splintered and descended into organized crime, they also regularly kill each other. Besides Santoni, 27 men were murdered in turf battles in 2001, a reminder of the pre–World War II days when

Corsican politics was dominated by clans. While they generally avoid violence against civilians and tourists, the clandestins sometimes murder an official, as they did in 1998, when assailants gunned down the island's prefect (the highest-ranking French official in Corsica) as he walked to an opera performance. The triggerman has never been caught.

For all its uproar, Corsica's independence movement is a quixotic undertaking; its aboveground political arm, called Corsica Nazione, won only 17 percent of the most recent vote for the Assemblée de Corse, or Corsican legislature. Yet the Corsican urge for independence has significance beyond the shores of France's smallest political region, with only 261,000 residents. Corsican politics resonate so loudly because for two decades a decentralization movement has bubbled throughout France, and its leading edge—some would say its bleeding edge—is what happens on this island.

Since the French Revolution of 1789, a centrally governed France has hewed to the notion of a single national identity: Every Breton, Basque, Alsatian, Savoyard, and Corsican is a Frenchman, and that's that. Claiming the right to use a separate language or have special rules and increased local control contradicts France's traditional definition of itself as "*une et indivisible.*" Thus every inch of territory, every aspect of administrative life, is ruled from Paris—right down to the police,



Tradition endures in Calenzana in Corsica's interior, where shepherd Jean Christophe Savelli, at center, helps haul off a billy goat to keep it from romancing a pregnant female. Until recently, sheep and goat herders formed the heart of Corsica's economy, and life ambled by in the slow lane. It still does in Aregno (below), population 570.

the selection of high school teachers, the local waterworks, the fire department. While separatist movements are not new in the republic—the Basques and the Bretons have proclaimed their cultural differences for years—it is the Corsicans, with their unrelenting demands and ongoing violence, who have driven it to the top of the national agenda. They want more local control over everything from schools to roads to utilities.

"Political leaders all over France are discussing the question of local powers," said José Rossi, president of the Assemblée de Corse and a member of the French Parliament, in his spacious office overlooking the Mediterranean in the capital of Ajaccio. "That's why the Corsican question is truly a national issue. If the issue of local power is finally confronted, it will have been Corsica that triggered the debate."

Part of the reason is the Corsican sense of separate identity. When Corsicans greet each other, they're more likely to say *"Bonghjornu, cumu va?"* than the standard French *"Bonjour, comment ça va?"* When they drink, it's *"A a saluta!"* rather than *"À votre santé!"* These are the Italian-sounding words of the Corsican language, a locally spoken tongue with Etruscan, Ligurian, and Iberian roots that was heavily influenced by almost 500 years of rule by Genoa. The language was not written until the late 19th century. But even today most of the Corsicans I met—except for some of the younger generation—had learned Corsican before French; it binds them like a secret code.

There is such strong sentiment for preserving

the island's cultural heritage that many Corsicans would like to make the Corsican language a mandatory school subject. At the same time there has been a revival of traditional Corsican music—haunting polyphonic laments and ballads that sing of clan rivalries, young widows, and aging mountain shepherds.

"We were losing our heritage, so it was important to stay here and save it," said singer Petru Guelfucci as we talked one afternoon beside a fountain in his home village of Sermano. Sermano, spelled Sermanu on the Corsican sign at the village's edge, hugs a steep slope near the ancient Corsican capital of Corte in the island's center. Guelfucci has had such recording success—he has made seven CDs and his song "Corsica" was an international hit in the early 1990s—that he could have led a glamorous life in mainland France. Instead he decided to remain in the Corsican interior and open an academy for his people's traditional music.

CORSICANS have a history of making notable contributions to French politics, culture, and business. Corsicans were, in many cases, the primary administrators of France's colonial empire and often its main engineers, farmers, and builders—especially in Indochina. Today one of the country's leading music groups, I Muvrini, is Corsican and sings mainly in Corsican, and the editor of *Le Monde*, France's best known newspaper, is Corsican.

Yet Corsican identity is also rooted in part in a long-festering sense of discrimination. Corsicans often feel looked down upon by French mainlanders. "I love Corsica, but I dislike the Corsicans," says a Parisian I know who spends all his vacations on the island. "They'll shoot each other over a parking space."

In the popular French mind Corsicans remain the hillbillies of France, the untamed wild people of an impenetrable island who are part Italian, part mafioso, part lazy. Sometimes this prejudice takes humorous forms both sides can live with. Three years ago a comic book called *L'Enquête Corse (The Corsican Investigation)* became a huge best-seller. (Comic books in France are real, hardcover books and extremely popular.) It was the mock story of stumblebum French cops chasing down stumblebum Corsican clandestins. The tale's repeated refrain was "*Boum!*"—the sound of bombs going off in the night, a code word for life in Corsica. The book was a hit with both Corsicans and mainlanders but reinforced the exaggerated image of Corsica as all violence, no life. It did nothing, however, to stop two million tourists, mostly

"We entered a fine harbor there, all walled around by a great unbroken sweep of sky-scraping cliff and two steep headlands fronting each other." Many think Odysseus' description of the land of the Laestrygonians fits Bonifacio (above) on Corsica's southern tip (map). Travelers still come to Bonifacio to marvel at the chalky limestone cliffs looming over the harbor where they imagine Odysseus moored his "black ship."

French, from visiting the island the next year.

By contrast, a single line in a humor show on French national radio ignited a firestorm. Playing a mock prime minister, the show's chief comic jested that Corsicans were not only ignorant but also had a perverse fondness for their animals. Corsican politicians rose up with one voice, howling in protest at the maladroit joke. Even the prime minister's office objected. The politicians demanded—and got—an apology from the show's producers.

Such incidents are not forgotten; they perpetuate the Corsican sense of grievance and the desire of some for independence from France. The more the mainlanders—*les continentaux*, as they're called in Corsica—look down on the Corsicans, the more it reinforces their sense of separateness. Months after the incident, Maurice Giudicelli, a separatist spokesman, invited me to his newsstand and tobacco shop in Ajaccio for coffee. "I can laugh at many things," he said, "but not at a French radio show that says Corsicans are inbred degenerates. The French media never say things like this about Jews, Arabs, or anyone else—there would be an immediate lawsuit."

Giudicelli is so wedded to the idea of a separate Corsican identity that he sees Corsican independence as the most natural thing in the world. "In the past 20 years the notion of a specific Corsican people has become widely accepted. We're not historically French, that's clear! If they give us independence, the Corsican problem will be resolved," he said.

But to many Corsicans—people like Marie Penciolleli, an elderly woman in the old capital of Corte—Corsica is simply part of France. She put it to me bluntly: "We are French, and we want to stay French! My forefathers fought in Belgium, in Alsace, and died in war. I was born in my grandfather's house right there, the white one." She pointed up the

Oblivious to all but each other, an amorous pair indulges in the warmth of Algajola's beach, one of many enticing spots along Corsica's 650 miles of coastline. That coast is scalloped with natural harbors like the Gulf of Rondinara (right), a calm haven for sailors. The cash of two million visitors a year underpins Corsica's tourist-driven economy.

steep slope to a row of ancient homes in the lee of the town castle. "I've had it up to here with the separatists."

THOUGH FRANCE annexed Corsica in 1769, today's political upheaval dates from 1962. That's when France's war in Algeria ended in independence for the North African nation, and thousands of French *pieds-noir* (literally, "black feet") fled Algeria for Corsica, where they soaked up land and agricultural subsidies that had been intended for hard-pressed Corsican farmers. Experienced in viticulture and savvy in business, the pieds-noir soon outflanked the native growers and dominated the market, incensing the Corsicans. The settlers also brought scandal, with shady dealings, including fortifying their wines by illegally adding sugar. Tensions came to a head in 1975 when Corsicans stormed a winery, killing two French gendarmes and torching the property after proclaiming the beginning of an uprising. It was later put down by tanks and troops sent from mainland France.

But the independence movement lived on. Its main operating arm for many years was the Front de Libération Nationale de la Corse (FLNC)—the Corsican National Liberation Front. Outlawed and driven underground because of its violent methods, the FLNC began blowing up new construction along the coastlines, a way of telling French mainlanders and developers to stay out. At its peak in 1982 there were 766 such bombings, but they have been decreasing ever since, as the independence issue has moved into the political arena. Even so, in 2001 there were more than one hundred bombings, usually in the dead of night when no one could be hurt.

I saw one example on Corsica's southern coast: a low-rise hotel started by an Italian firm had been blown up in mid-construction. Now its concrete shell stood empty and forlorn, like the ruins of a World War II bunker. The message had been heard; construction had ceased.

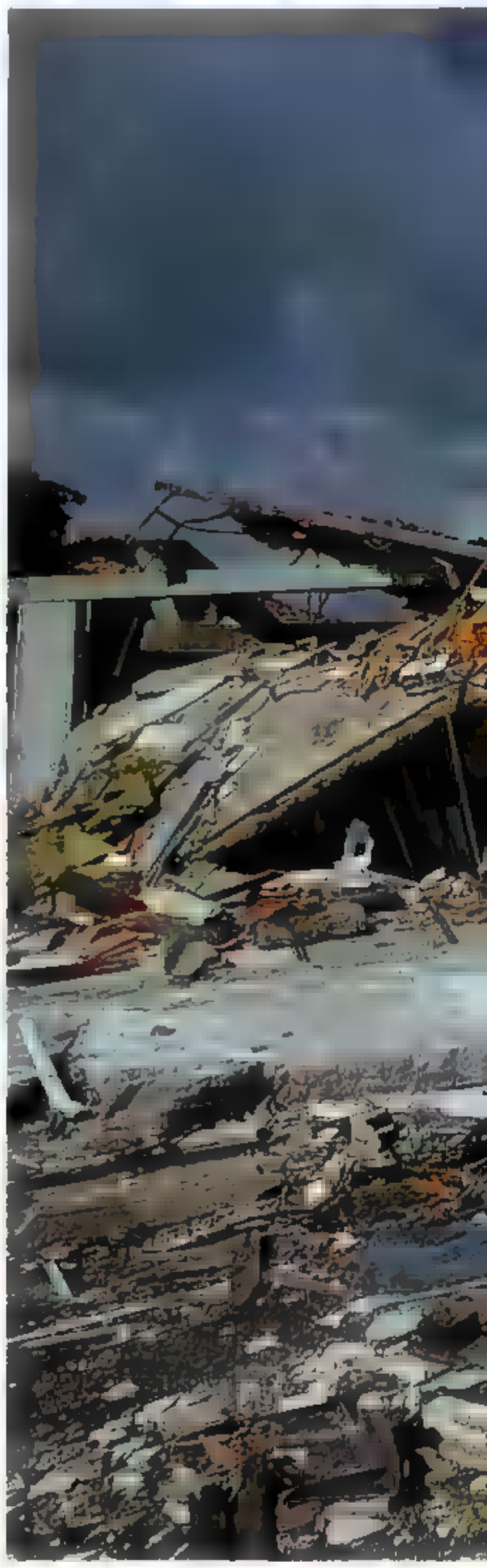
In some cases separatists use the threat of bombings *for simple extortion. That's what* had sent François Santoni to prison for a

Clouds can't dim the smiles of newlyweds Veronique and Didier Cuenca as they leave the church of St. Michel de Murato, built by Corsica's Pisan rulers in the 12th century. Young Corsicans no longer routinely flee the island for jobs. "The future is brighter now," says Didier, a high school art teacher.

short term several years before his final reckoning. A developer of luxury homes on the southern coast refused to pay the $800,000 in protection money (euphemistically called a revolutionary tax) demanded by Santoni's gang. For his pains, the developer's gatehouse and sales office were bombed. But he fingered the bad guys—a rare case in Corsica of a victim publicly taking on the racketeers—and they went to jail.

Despite the obvious criminal connections of these nationalists, many Corsicans who condemn violence still credit the bombing tactics with saving Corsica's coastline from rampant development. "I don't encourage violence, but I'm absolutely in agreement with bombs that stop seashore construction," said writer Jean-Claude Rogliano at his 700-year-old stone house in the Castagniccia forest. Rogliano's first book, *Mal' Concilio (Shepherd of the Dead)*, published in 1974 and reissued in 2001, was a novelized search for roots that struck a deep chord in Corsica.

CERTAINLY, THE BATTLE for the shorelines is an important one: Corsica's 650-mile littoral constitutes 20 percent of France's coastline and is one of the last pristine spots in France. Representatives of Corsica's legitimate environmental movement fear what they call the "paving over" of the island, much like the Riviera or Miami



Gone but not forgotten, a bombed nightclub between Bonifacio and Porto-Vecchio testifies to Corsica's violent ways. What led to the attack? Perhaps a feud, perhaps an extortion attempt, or perhaps nationalistic resentment about French intrusion on Corsican turf. At the old cemetery of Calvi (below), French Foreign Legion troops depart after a ceremonial parade honoring the island's dead.

Beach. The threat of bombing or extortion has indeed discouraged investment and left the coasts relatively empty, the tourist facilities relatively modest, and the island without much economic growth.

"Have you seen what they've done to the rest of the French coasts?" asked Gérard Boncristiani, an environmental leader. Like so many Corsicans, Boncristiani lives in a coastal town—Porto-Vecchio—but spends his summers in an ancestral village high in the mountains, in this case Cantoli near Quenza. Sitting beneath a 150-year-old chestnut amid shepherds' cottages once used for the summer transhumance, Boncristiani explained why he became an ecological activist. "When I tried to go to the beach with my children, I found more and more hotel gates with signs saying, 'No Public Access.' We started a movement called the Association for Open Beach Access and Coastline Protection. We have to avoid letting speculation and profit ruin our region."

Traveling up the fjord-like west coast from Ajaccio, I learned why so much is made of saving Corsica's shores. Following a serpentine route around scalloped bays and granite cliffs, I finally crossed the 1,600-foot Lava Pass. Laid out before me was the breathtaking Gulf of Porto, a deep inlet between towering peaks that narrowed to the tiny village of Porto.

The next day, touring the Scandola Nature Reserve by boat—a 4,700-acre land-and-marine park that is a UNESCO World Heritage site—I viewed miles of unspoiled coastline and rare bird habitat and a nearby harbor

town called Girolata that is approachable only by boat or on foot over the mountains. On Corsica's southern tip, I found the island's most improbable endowment—the 200-foot chalk cliffs of Bonifacio, white sentinels watching over one of the world's perfect natural harbors. Odysseus paid an ill-fated visit here a while back (*Odyssey*, Book 10), and today the café-lined harbor is choked with the 120-foot sailing yachts of Europe's rich and beautiful. On the high cliffs stands an old Foreign Legion fort and a graveyard whose stones told much of Corsica's history.

To preserve and exploit the island's cultural and natural heritage, Corsica's chief of economic development, Jean-Claude Guazzelli, wants to face down radicals on both sides of the development debate. "The ecologists want to do nothing, the developers want to do everything," he said one morning in a café in Bastia, a northern port city. "They're both extreme, and they're both wrong."

Unlike most Corsican political leaders, Guazzelli, an intense man with blue eyes and curly gray hair, sees Corsica's challenge as more economic than political. "It's the lack of a real economy," he insisted. "All we have is a six-month tourist season"—Guazzelli pointed to one of the high-speed ferries just arriving in a nearby harbor—"and minor agriculture. That is not an economy."

Creating a new economy based on sophisticated tourism, said Guazzelli, is the key to ending Corsica's violence. He wants to develop both ecotourism and luxury vacations focused on everything from beaches to rock climbing,

Responding to an ancient muse, members of the a cappella group La Cumpagnia pour out haunting traditional Corsican folk songs of love, life, and death at a bar in Pigna. Enjoying a revival, "this music is what the root is to the tree," says artist Toni Casalonga—"in contact with the Earth and producing new fruit."

music to wine growing, horseback riding to ecclesiastical concerts. This goal is shared by José Rossi, the Assemblée de Corse's president. "We don't need any more vans coming off the ferries with a month's supply of sausage and beer and staying only at campsites," Rossi says. "We need value-added tourism."

FOR ALL SUCH HOPES of change, life on Corsica proceeds for the most part according to the classic rhythms of Mediterranean traditions and customs. Fishermen like Josef "Petit Jo" Ricco start their engines at five every morning in the harbor of Calvi, a citadel town in the northwest, to get their day's catch of lobster and red mullet. By evening the cafés lining the curved port boulevard known as the Croisette are filled with the young and flirtatious, playing their ancient games. Far off in the mountains goatherds like Josef Aquaviva, who keeps two rifles and a shotgun in the umbrella stand beside his front door, tells visitors about the day he shot seven boar out of season—a classic combination of Corsica's national pastime and the Corsican's historic disregard for laws written elsewhere.

Although something was blown up almost every other day I was on the island, I never heard a *boum!* Instead I read about it in the newspapers when I sat down for my usual morning coffee at the Grand Café Napoléon in Ajaccio (the emperor was born only four blocks away) in the company of old men on rattan chairs debating the latest news. Once one of these regulars got into a shouting match with a TV reporter from Paris who, following the Santoni murder, had come to explain the "island of violence."

"We're just as peaceful as anywhere in France!" declaimed the Corsican. "But you have more crime!" retorted the journalist. In fact, statistics show that crime in Corsica is below the national average—except when it comes to targeted assassinations and political bombings. So both men were right, even as they shouted right past one another, a telling microcosm of the Corsican dilemma.

Still, progress was being made as news filtered down that Paris was moving ahead with the law to give Corsica greater financial and political autonomy. (The new French government elected last year is considering a special development fund for Corsica; as José Rossi had predicted, Paris pushed national decentralization to the top of France's agenda.) If Santoni's killing had punctuated the beginning of my visit, as I read the newspaper on my last day, I was reminded of the other Corsica: In a rocky village high in the mountains, in a tiny chapel like the one used for Santoni's funeral, Samuel and Aurélie, a couple from mainland France, had gotten married to the cheers of the locals. In keeping with an old Corsican tradition, the bride arrived on a donkey. ▯

WEBSITE EXCLUSIVE

Should Corsica be allowed to separate from France? Share your thoughts and get wallpaper images at **nationalgeographic.com/ngm/0304**.

LESSONS FROM GOMBE, TANZANIA

Fifi fights back

Four decades after I began studying the chimpanzees at Gombe National Park, Fifi and her family are still stars of the animal kingdom. But will fame be enough to save them from extinction? By Jane Goodall

A mother again at 44, Piti shows no signs of slowing down

PHOTOGRAPHS BY ANUP SHAH

It's been more than 40 years since I first set foot on the sandy beach of what is now Tanzania's Gombe National Park. The steep, heavily forested valleys and cascading streams on the shores of Lake Tanganyika formed the backdrop for one of the most thrilling phases of my life. Though I was armed with little more than secretarial training and a passion for animals, paleontologist Louis Leakey gave me a mandate: Get the wild chimpanzees to accept you, observe their behaviors, and describe what you see. The rest, thanks in no small part to the National Geographic Society, is well-documented history.

We knew so little about these secretive creatures back then that everything seemed like a revelation. What were once thought to be peaceful, simple vegetarians turned out to be powerful, highly intelligent hunters with complex personalities and emotions: beings capable of communication, altruism, political alliances, infanticide, warfare, and tool making—the last once thought to distinguish humans from the rest of the animal kingdom.

Unaware of the scientific prejudices of the day, I gave the chimps names and described their rich personalities in human terms, a practice that drew scalding condemnation from some scientists. I readily admit that I was fond of certain chimpanzees. And I believed that having a degree of empathy for my subjects could help me detect slight changes in their mood or attitudes and provide insights into their complex social processes. I think time has proved me right.

Though I stopped active field research in 1986 to focus on chimpanzee conservation, I left the Gombe Stream Research Center in the able hands of a new generation of scientists and dedicated Tanzanian field staff who now follow a new generation of chimps. It has become one of the longest continuous studies of an animal group in history. This body of work has spawned numerous research papers, doctoral theses, and books, providing insights not only into intricacies of chimpanzee behavior but into the lives of early humans as well.

Today I head to Gombe whenever I'm able to escape from a schedule that keeps me lecturing and traveling more than 300 days a year, spreading the word about the plight of chimpanzees in the wild and in captivity. I like to walk alone to an area called the Peak, close to where the chimpanzee I named David Greybeard first accepted me 43 years ago. He was the first individual I saw making a grass stem to fish termites out of their nest, an observation that prompted Leakey's famous remark: "Now we must redefine Man, redefine tool, or accept chimpanzees as humans." When David Greybeard died of pneumonia in 1968, I mourned for him as I have for no other chimpanzee.

Even after all these years, the vivid Gombe characters continue to surprise and delight us. Last October, Fifi, the only surviving chimpanzee I knew as an infant in the early 1960s, delivered her ninth offspring at age 44. Most females don't raise more than two or three offspring to reproductive maturity, but Fifi has four adult offspring, two healthy adolescents, a juvenile, and now a brand new infant. Her high rank allows her to control a particularly food-rich patch of habitat in the central Kakombe Valley, which contributes to her phenomenal breeding success. All but one of her offspring have survived, including Frodo, the current dominant male. At 121 pounds he is the second largest chimpanzee ever recorded at Gombe—and he rules with an iron fist.

Gremlin, one of my longtime favorites, is currently raising the third set of twins in the record books at Gombe. Survival for twins, who must compete for a limited supply of milk, is hard. But with Gremlin's patient nurturing, both Golden and Glitta, now four, are thriving. One

of the best termite fishers in the community, Gremlin is also providing researchers an excellent opportunity to learn how such skills are passed down from generation to generation.

New technologies have facilitated exciting breakthroughs. By using DNA analysis of fecal samples, we can for the first time determine the paternity of many of the chimps, allowing us to examine the relationships between males and their offspring. We know that females avoid mating with their brothers and sons, but now we'll be able to learn whether an incest taboo exists between fathers and daughters as well.

Unfortunately, some of the news coming out of Gombe is distressing. Growing human pressures on the park threaten the chimpanzees' very existence. Unlike the vast swaths of forest that still surround chimpanzee populations in central Africa (See "New Hope in Goualougo," page 90), Gombe National Park is only eight miles long and one to two miles wide, lying at the far eastern edge of the chimpanzees' natural range. When I arrived in 1960, the reserve was surrounded by large tracts of undisturbed forest that stretched to the east and south, with strips of

In chimpanzee society, having more children means more allies and higher status, making Fifi (carrying daughter Flirt, above) the matriarch of Gombe. Two of her sons have taken a turn as the group's alpha male, most recently Frodo (below), who now reigns supreme. "If Frodo sits up, both chimps and humans freeze," says Gombe researcher Elizabeth Vinson Lonsdorf, who bears a permanent scar from a push by the volatile animal.

forest to the north that linked the Gombe chimps to those in nearby Burundi. That habitat outside the park has all but vanished. New maps produced by Gombe researchers clearly show that it has become a 13.5-square-mile patch of forest surrounded by farms and denuded hillsides.

Though small villages have always existed in the area, the population density rose dramatically during the past decade, fueled by waves of refugees fleeing bloody civil wars in Burundi and the Democratic Republic of the Congo. The United Nations estimates that nearly a million have escaped from Burundi alone, with thousands settling in camps and villages in the Kigoma region around Gombe. The growing demand for wood, food, and charcoal has led to illegal logging and the snaring of wildlife within the park.

Yet it's the loss of the surrounding forest that poses the greatest threat. Gombe was once home to about 150 chimpanzees in three communities. Today, that number has dwindled to about a hundred. Although the main study group, known as the Kasakela community, has maintained its population of about 50 individuals, the northern and southern groups, which once foraged outside the park, are in decline. Only two or three adult males are left in the southern group. Unless we can enlarge existing habitat corridors linking the park to communities in the north, the Gombe chimpanzees could succumb to disease or inbreeding within decades.

It doesn't have to end that way. We have the good will of most of the people living near the park, which means the enlarged corridors may someday be a reality. Researchers have learned that if villagers leave the stumps on the bare hillsides rather than hacking at them for firewood, the miombo woodlands will regenerate within five years. Patches of resprouted trees now border the lakeshore. Conservation education and micro-loans to women who practice sustainable farming are beginning to have an impact.

Perhaps the most important thing we've learned at Gombe is how similar we are to these creatures, with whom we share between 95 and 98 percent of our DNA. As we watch their numbers dwindle and their forests fall, their legacy becomes as clear as a Gombe stream: As they go, so, one day, may we.

Gombe
An Island Habitat

When Goodall came to Gombe in the 1960s, about 150 chimpanzees inhabited the area. Today about a hundred survive in the dwindling forest. "When the first satellite images were taken of Gombe in 1972, there was little difference between what was inside the park and what was outside," says conservation biologist Lilian Pintea of the University of Minnesota, who used high-resolution satellite imagery to

create this current map. Today Gombe, only eight miles long and one to two miles wide, is surrounded by farms and people, including thousands of refugees fleeing violence in nearby countries.

Black patches on the hills above the Kizuka Stream show areas recently burned for agriculture. Such deforestation contributed to a flash flood in Mtanga village in 2001 that killed dozens of residents and destroyed about 30 homes. "What is happening to Gombe is happening to many other habitats in Africa and around the world," says Pintea, who is working with locals to restore the forests outside Gombe and enlarge corridors to other fragments of chimpanzee habitat. "We have to recognize that people are part of the landscape, so they have to be part of the solution."

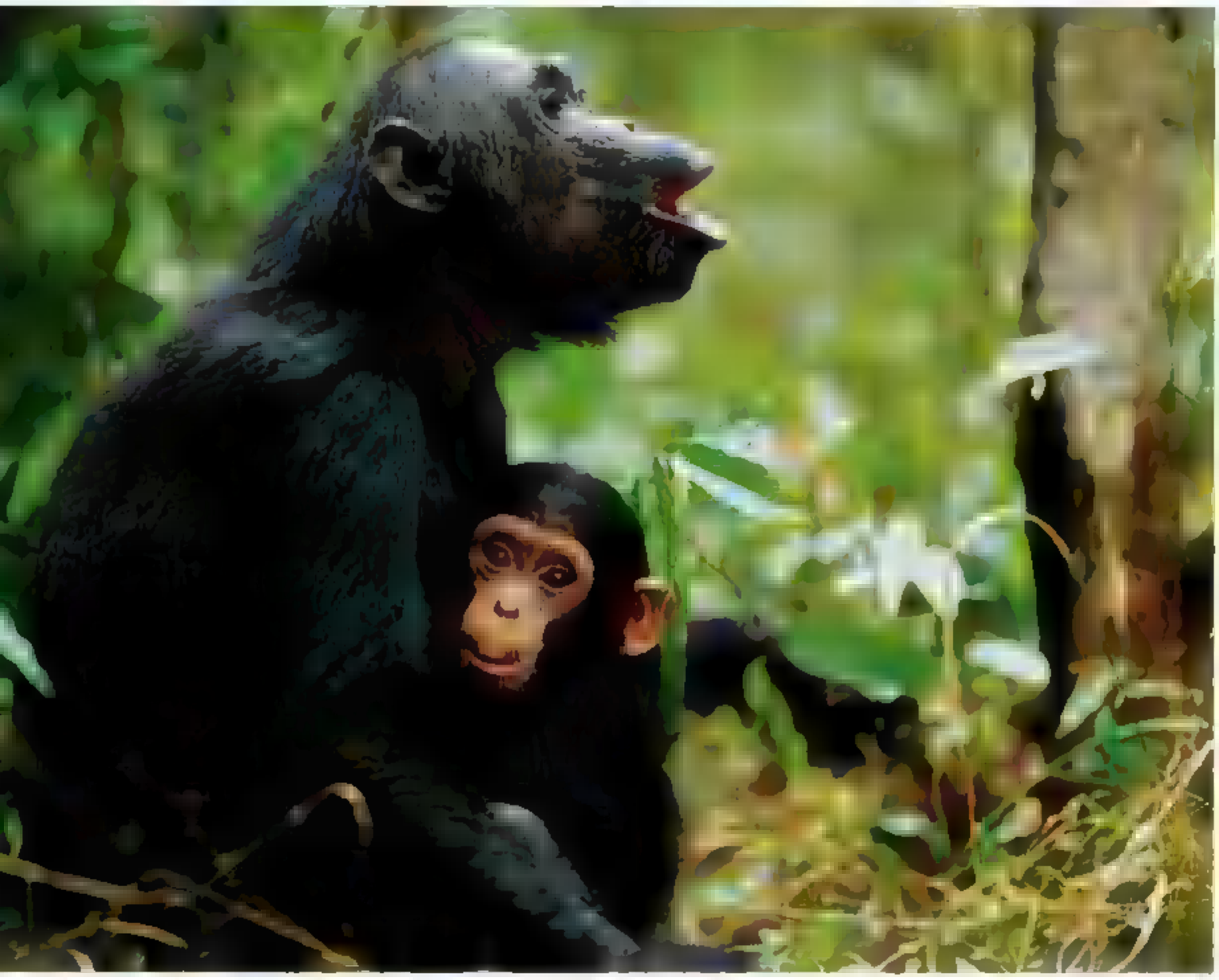
Flirt is assertive. If the chimps survive,

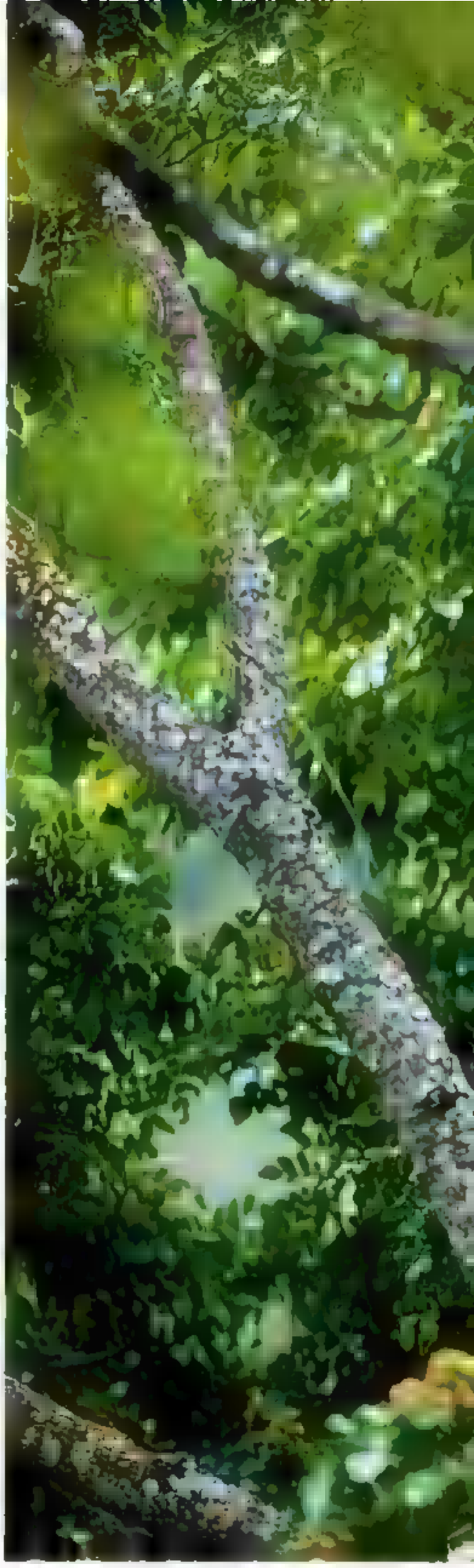
she'll probably be a dominant female.

With her mother a high-ranking female and her brother the dominant male, four-year-old Flirt is Gombe's golden child, often pouncing on brother Frodo's head just for fun. Goodall's study shows that daughters of high-status mothers who can monopolize food resources grow faster, survive better, and reach sexual maturity up to four years sooner than daughters of lower ranking chimps. Goodall, who names the infants, often uses alliteration to keep track of matrilineal lines, such as the "F" family (below).

FLIRT'S FAMILY

Jockeying for position,
the younger males will
display in front of Frodo.
They get royally battered.



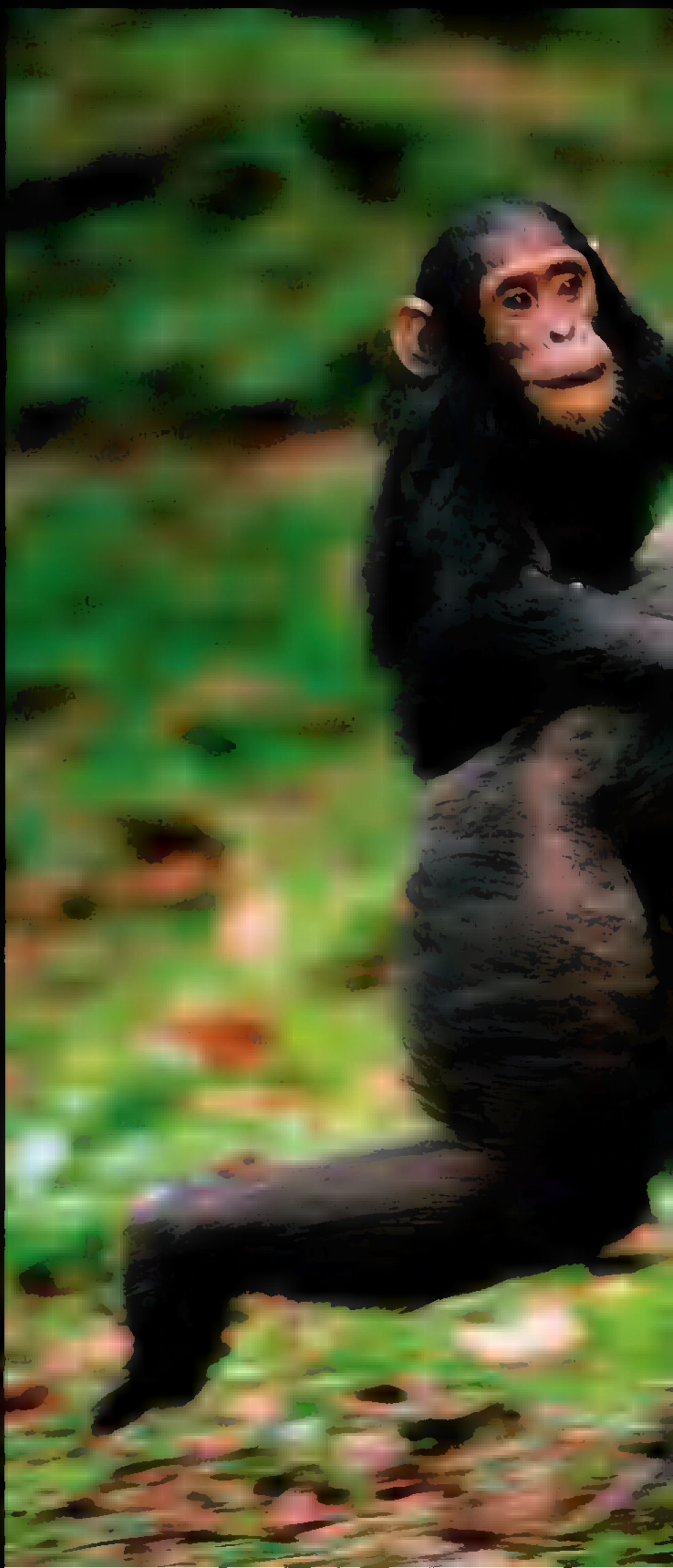


SCREAMS OF EXCITEMENT shatter the stillness of the forest after the capture of a bushbuck fawn, held by Frodo (above). One of the most surprising discoveries in Gombe was not only that chimps are adept hunters, but that meat is a valuable and relished source of fat and protein. Frodo is by far the most successful hunter, recently catching as many as 20 young colobus monkeys during the three-month dry season from August to October, when most hunting occurs. Even if he doesn't make the kill, Frodo often ends up with the carcass, as was the case above: He snatched the fawn from a young male named Sheldon before knocking him out of the tree. Once the prey is caught, the begging begins. Some researchers have theorized that chimpanzees share meat to establish and maintain alliances. But Ian Gilby, who has studied Frodo's hunting habits for the past four years, doesn't think that's the case here. Rather, Gilby believes the most persistent beggars, such as Goblin, at center, and Fifi, at right, get the meat. "The bottom line," says Gilby, "is that Frodo doesn't need allies."

Two-year-old Fundi still needs his mother, Fanni, who holds her son while answering a group call (top left). Fundi will likely stay with his mother until he's seven. Pax (left) is the lowest-ranking male of the group. A wound suffered in infancy during an attack by chimpanzees from the south left him impotent. Now he mostly plays with young chimps, earning him the nickname Peter Pan.

Gremlin is very gentle. She's extremely

Faster, Mom, faster! Four-year-old twins Golden (in front) and Glitta (clinging for dear life) spur their mother Gremlin on as she accelerates through a forest clearing. The twins have been lucky. Only days after they were born, Gremlin fended off an hour-long attack by Fifi and daughter Fanni—eerily similar to the infanticide practiced by a chimpanzee named Passion and her daughter Pom in the 1970s. Once thought to be abnormal, such behavior may be an ever present threat from high-ranking females.



TWINS' FAMILY

attentive to the twins' needs.

TOOL MAKING, first seen in Gombe by Goodall in 1960, is passed down from one generation to the next. Gremlin shows how it's done (above), using a stem to extract soldier termites from a mound as Glitta watches intently. "We haven't ever seen active teaching at Gombe, like a parent showing a child how to tie his shoe," says Elizabeth Vinson Lonsdorf, who is studying the acquisition of tool-using skills. "It's completely observational learning. They can see they need a tool and a termite mound, and that they need to insert the tool into a hole." After that, she says, they're on their own.

Sometimes the tool must be inserted two feet into the twisting termite tunnels, then gingerly withdrawn so that the termites are not knocked off. Gremlin catches up to seven a minute, or a stomach-tickling 400 in a typical hour-long session. Glitta was fascinated by the process and picked it up quickly, while Golden (with stem in photos at right) initially preferred stealing termites from her sister and mom. Now both the twins are adept termite fishers. And they've beaten the odds. Golden and Glitta are the only known twins born in Gombe since 1960 to have each survived longer than 18 months. Whether they will survive the human tide rising around them remains to be seen. □

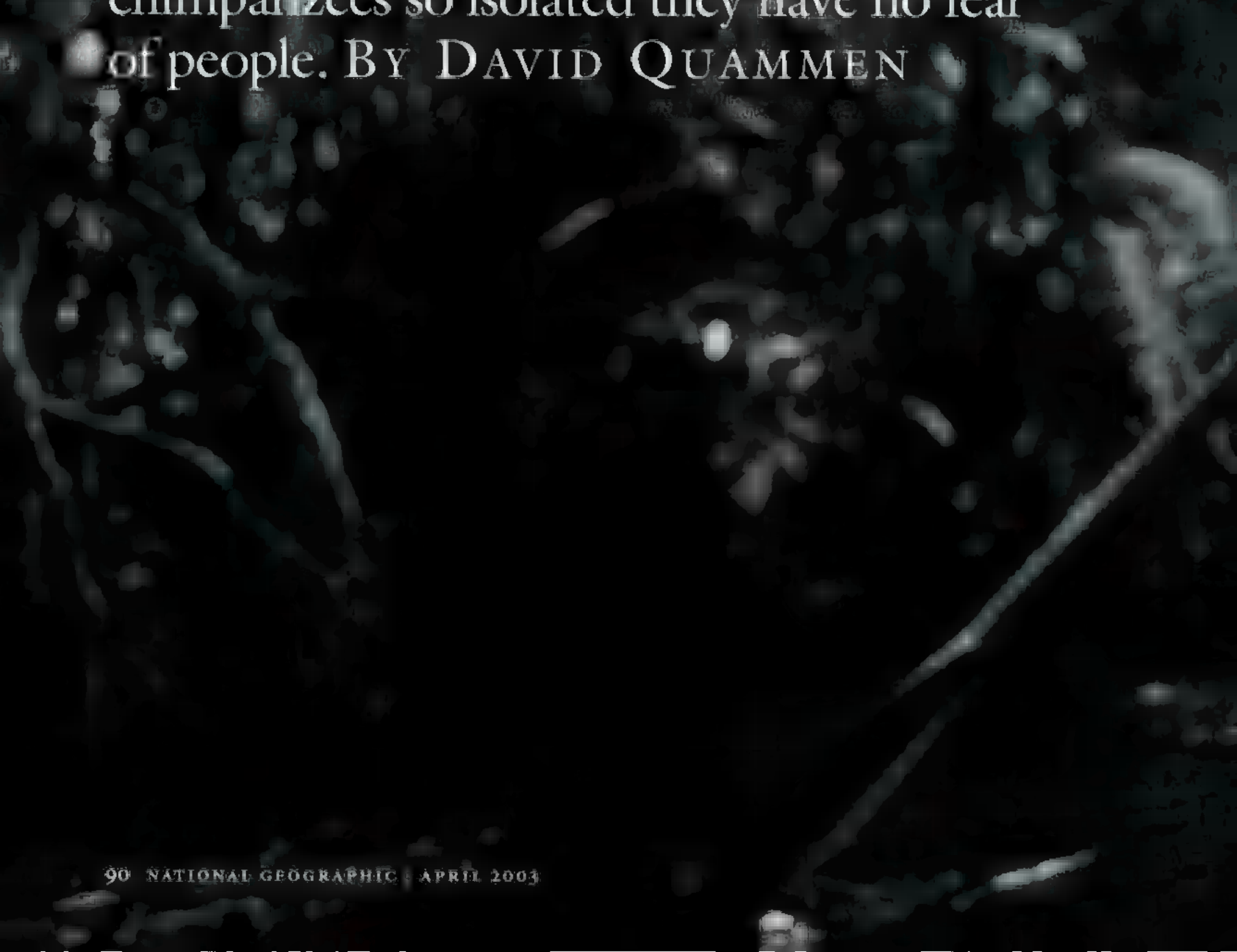
WEBSITE EXCLUSIVE

Find a gallery of images of the Gombe chimps, an update on the new generation, and a listing of related resources at nationalgeographic.com/ngm/0304.

Chimpanzees use more objects as tools for more purposes than any other animal besides humans.

Jane in the forest again

Conservationist Mike Fay said he needed Jane Goodall's help, so the world's most famous primatologist made a pilgrimage to some of Earth's most innocent animals—chimpanzees so isolated they have no fear of people. By David Quammen

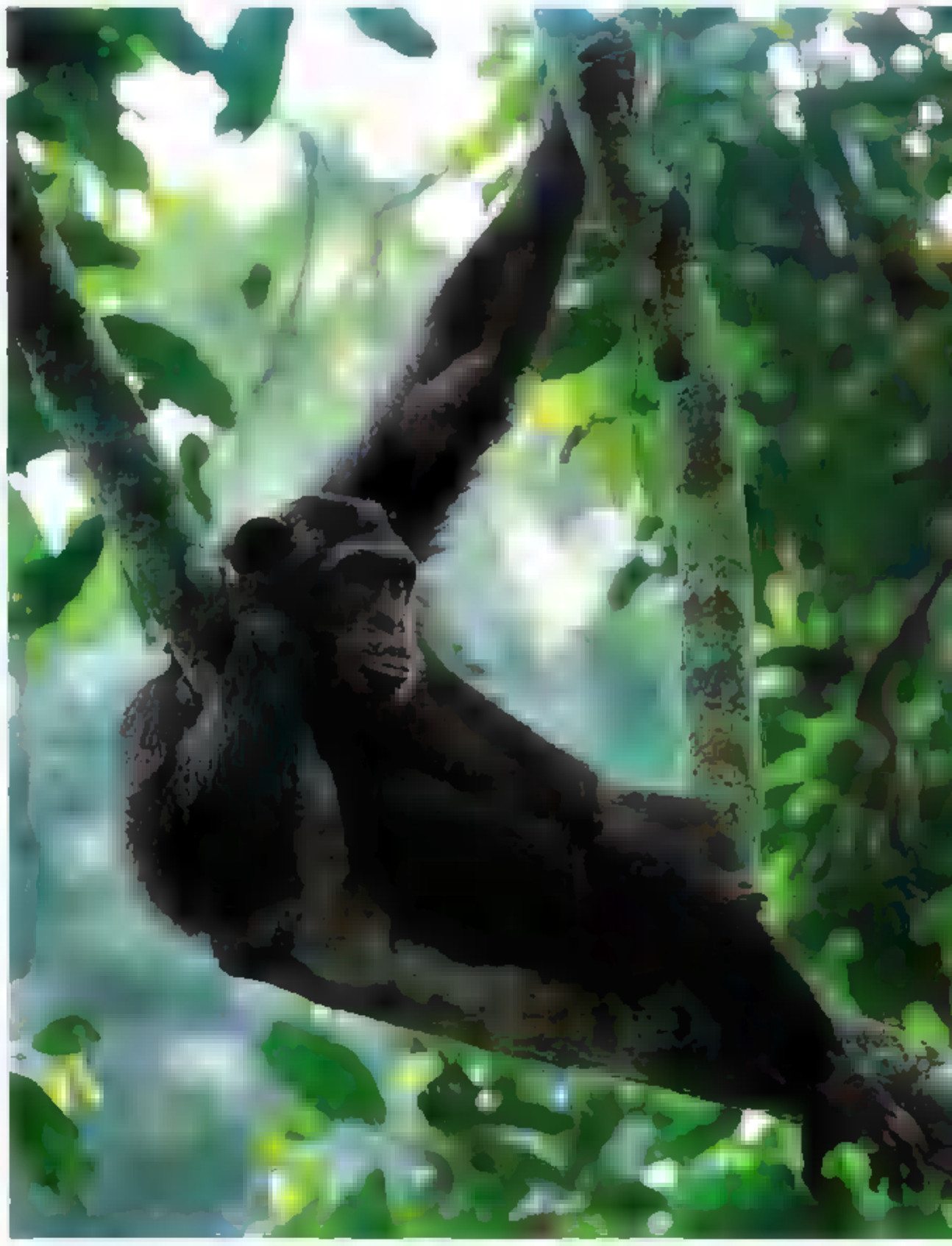


PHOTOGRAPHS BY MICHAEL NICHOLS
NATIONAL GEOGRAPHIC PHOTOGRAPHER

It was an amazing display of bravado from a species not generally perceived as being fierce. The chimpanzees moved in through the treetops, hooting and shrieking like a pack of hungry predators on the hunt. At that moment, in fact, hungry predators was just what they were. Diving from limb to limb, gabbling excitedly, they set up a menacing ruckus. Vines shook. Branches fell. Using their weight and their strength, they stirred the canopy like storm winds. Their war whoops were spookier than martial bagpipes on a Scottish moor. Intermittently they paused to crane and ogle, scanning the ground ahead for a glimpse of their prey. Chimps, after all, are by no means vegetarians; they eat fruit and leaves routinely but relish flesh when they can get it. This group had been drawn by the bleating moans of what they took for a duiker (a small forest antelope) in distress—and a distressed duiker, to them, represented a potential bounty of protein. Maybe they expected to find a wounded adult, or a newborn fawn, or at least a pile of succulent afterbirth. Anyway, they hadn't yet realized that the duiker bleat was a decoy call, made by a Bambendjellé Pygmy named Youngai, who hunkered quietly amid the understory, waiting for them to come. And they didn't know that beside Youngai sat three other human visitors, each of us thrilled with the privilege of encountering chimpanzees so bold as to mistake us for meat.

As the chimps approached closer, catching sight of us on the ground, their excitement didn't lessen—but it changed. Suddenly they looked surprised and perplexed. We could see ourselves register weirdly on their awareness. They showed no fear, and their hunters' menace had dissolved. Now they were curious. They settled onto limbs just above our heads and lingered there, gawking, chattering, like a gaggle of fascinated schoolchildren getting their first glimpse into a monkey cage. One female chimp held an infant whose large ears stuck far out from its head, glowing amber like a pair of huge dried apricots whenever they caught backlighting from a shaft of sunlight. I gaped at the little fellow, just a dozen yards above. His face was tranquil, his eyes widened by innocent wonder. He and his mother gaped calmly back.

Dave Morgan, the younger of my two



Fixed on the treetops, Mike Fay, researcher Dave Morgan, Jane Goodall, and Pygmy tracker Djokin observe chimps. Some 380 live in Goualougo, their response to humans ranging from curiosity to indifference. One friendly female (above) earned the name "Jane."

American companions, positioned his spotting scope and began fixing on one chimp after another, looking for facial markings of distinctive identity. The other scientist of our little group, J. Michael Fay, put his video camera into action. They were both seizing precious minutes of close contact to document one of the most arresting phenomena to be found in an African forest:

chimpanzees so remotely isolated that they showed no sign of ever having been hunted, or frightened, or otherwise contacted by humans.

Hours later, after we had stumbled through gathering darkness into a swampy campsite, we discovered that the chimps had followed. That night they bedded in treetops just a short stroll away. In the morning they were with us again. We moved slowly through the forest, and, a day later, one chimp approached by foot to within 20 paces of our morning campfire. He stood behind a tree, peering nosily. Maybe he fancied the smell of coffee.

The date was September 28, 1999. It happened also to be Day 9 of Mike Fay's epic survey hike across central Africa. (See the "Megatransect" series: October 2000, March and August 2001.) Our location was deep in the northeastern corner of the Republic of the Congo, within a spectacularly pristine wedge of forest known as the Goualougo Triangle. From this point Mike Fay would keep walking—and walking and walking—until he reached the Atlantic Ocean, 447 days later. Dave Morgan would remain behind, continuing his study of the Goualougo chimps. None of us foresaw that three years later we'd be together again, joined in our search for another glimpse of these trusting animals by the world's foremost chimpanzee maven, Jane Goodall.

The return trip occurred last summer, just weeks before the World Summit on Sustainable Development convened in Johannesburg. Goodall was committed to attend the big gathering, which would include presidents, cabinet ministers, scientists, conservationists, development experts, and activists from roughly 190 countries. But in the meanwhile she had made space in her schedule for a quiet walk, with a few kindred souls, in the Congo forest. It seemed a good time and a good place to contemplate the future prospects—if any—for the survival of viable chimpanzee populations within large intact blocks of African forest.

Primate taxonomists currently recognize four subspecies within *Pan troglodytes*, the common chimpanzee, spanning a distributional range from Senegal on the west coast of Africa, through Gabon and the Republic of the Congo, into Uganda and southwestern Tanzania in the east. At one time that range may have been nearly continuous, but today the forest areas still occupied by chimpanzees present a map pattern of discontinuous remnants, small patches, and dots. Under pressure from humans, the species has suffered population decline, habitat fragmentation, and in some places local extinction. Although there were probably more than a million chimps in Africa a century ago, no more than about 200,000 (and possibly far fewer) survive today.

In many areas where humans and chimpanzees came into contact, hungry people treated *Pan troglodytes* as just another form of bush meat, and chimps learned that *Homo sapiens* can be lethally dangerous. When the source of conflict wasn't meat hunting, or the capture of infant chimps for the pet trade or for zoos, it was habitat destruction. Humans felled trees and cleared land for settlements and agriculture, wrecking the chimpanzee world, driving chimps away, leaving them marooned within remnants of habitat—little patches of forest such as the Gombe Stream Game Reserve in Tanzania, where Jane Goodall began her research career back in the summer of 1960.

Although Gombe is now a national park, it's a tiny one, just 13.5 square miles in area, bordered by Lake Tanganyika on one side and by deforestation along nearly all the rest of its perimeter. Its resident chimpanzees have been studied continuously for the past 43 years. To Goodall herself, each chimp has always been an individual, worthy of individual attention and concern—that is, in some sense a person—and many of those individuals became well-known through her writings. Readers worldwide remember her portraits of ragged-eared Flo, trusting David Greybeard, murderous Passion, and others. Their individual fame has tended to obscure the reality that, collectively, Gombe's chimps are few in number and perilously isolated.

The park now holds about 100 chimpanzees, which (as the modern science of conservation biology warns us) may not be a viable population. That is, it may be too small to renew itself indefinitely. Inbreeding could cause trouble. An epidemic might wipe out half the number, after which a drought, a fire, or some other natural catastrophe

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Going Fast

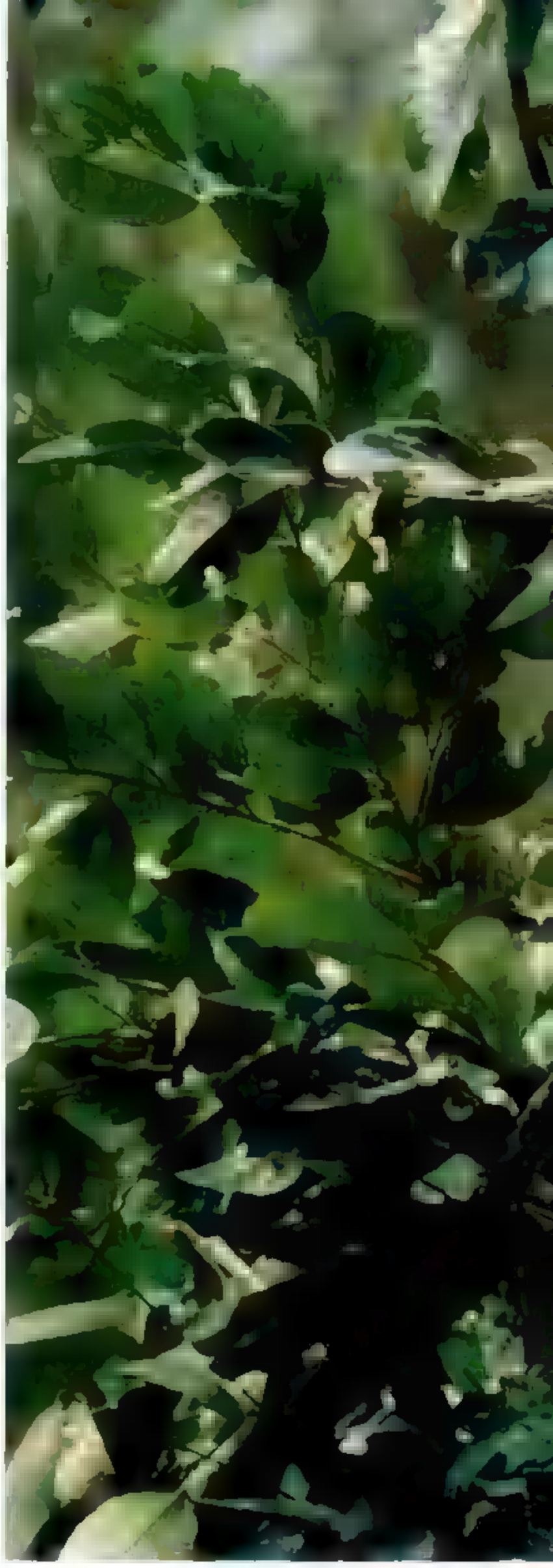
Logging roads crisscross much of the forest around Goualougo and could soon overrun a pristine sliver of chimp habitat to the east. Straight from the forest, Goodall and Fay went to Congo's president to lobby for this 37-square-mile area's protection. Keeping loggers out, they argue, will earn Congo more in Western aid than timber could ever make.

might reduce the other half to a still lower level from which recovery is unlikely. Even without further human incursion, even without poaching or persecution, a population so small and isolated faces some considerable jeopardy of extinction. Jane Goodall recognizes that dire prospect and is taking important steps to try to avert it. (See "Gombe Update," pages 76-89.)

The chimps of the Goualougo Triangle inhabit a much different set of circumstances and possibilities. Their peculiarity was first noticed by Fay himself in 1990, when he and a Congolese colleague, Marcellin Agnagna, made a series of exploratory hikes to survey forest elephant populations for a study sponsored by Fay's employer, the Wildlife Conservation Society (WCS). What seemed peculiar was this: These chimps didn't flee from the sound, smell, or sight of people. On the contrary, they sometimes approached, gawking, confident, and apparently fascinated. They were naive about any potential danger from humans—which suggested that they had never before experienced contact with *Homo sapiens*. The Goualougo was at that time so remote (unreachable by road, bush plane, or human trail) and so unsullied (there were not even any machete cuts of the sort left by Bangombé Pygmies of the adjacent region) that one could plausibly imagine it had gone unvisited by people for . . . well, maybe for centuries.

The exploratory treks by Fay and Agnagna led to the establishment, in 1993, of Nouabalé-Ndoki National Park, of which Fay became the first director. But when the park boundaries were drawn, in a process involving political compromise, the Goualougo Triangle wasn't

Naïveté is a delicate, perishable state of being, and the Goualougo chimps have already begun to lose theirs.



Graceful arms and a tiny face peering from a nest signal quiet time for mother Maya and daughter Malia, a well-known pair at Goualougo (above). Because they seldom travel far, females and their babies are easiest to watch. To locate chimps without disrupting their behavior, researcher Crickette Sanz and tracker Koba (above left) walk in silence, listening for cries. During Jane's visit, Mike tried "calling" chimps (left), imitating an antelope *in distress to draw the meat-*eaters from the forest.

included. The cone-shaped piece of spectacular chimpanzee habitat and old-growth hardwoods, delineated by the convergence of the Ndoki and the Goualougo Rivers, was left dangling beneath the park's southern boundary like a precious but vulnerable appendage. Instead of receiving park protection, it remained held within a timber concession. Eventually, in that status, it would likely be logged. In the meantime, remembering those eerily brazen chimps, Fay took steps to learn about them—with as little disruption as possible—before it was too late. In time, the assignment fell to Dave Morgan.

Morgan had studied biology at Western Carolina University and then worked several years as a zookeeper at Busch Gardens in Tampa, Florida. His job there was to feed and tend the captive gorillas and chimps. He had never been to Africa, let alone seen an ape in the wild, until Mike Fay recruited him. In late 1995 Morgan came to Nouabalé-Ndoki as a volunteer assistant on a WCS gorilla-monitoring project within the park. After having proved himself hardy and very capable, he wrote a proposal for a pilot study of the chimpanzees of the Goualougo. Fay, increasingly concerned that the Goualougo might soon be logged, arranged funding for the study and set Morgan to it.

On February 24, 1999, Dave Morgan began work, basing himself at a simple field camp in the Goualougo. The chimps as he found them still seemed blithely innocent of the possibility that humans might represent any threat. They sometimes approached

to within a few yards, lingering in trees just above, watching him as curiously as he watched them. He counted heads, observed behavior, sketched their faces in his notebook, and when possible captured them on video. By the end of September, despite a month lost for medical reasons (he'd been attacked and bitten by a distraught gorilla), Morgan had portraits of 93 individual chimps. "The naive behavior" of the Goualougo chimps, he wrote in his pilot-study report, "facilitates the rapid collection of a substantial body of data." And so the study continued.

At the end of 1999, during a visit back in the U.S., Morgan met a young graduate student named Crickette Sanz, then just beginning her work toward a doctorate in physical anthropology. Later she visited the Goualougo, in search of a dissertation project, and liked what she saw. Morgan and Sanz, assisted by a small crew of expert Bangombé woodsmen, now pursue the Goualougo chimpanzee study as a joint effort. Their work, coupled with the international attention thrown on the area by Mike Fay's Megatransect expedition, spurred ongoing negotiations between WCS and the logging company (Congolaise Industrielle des Bois) that until recently held the concession. The company has voluntarily relinquished its timber rights in the Goualougo—a generous act as well as a savvy one—so that the area can be annexed to Nouabalé-Ndoki National Park.

As a small complement to other conservation measures taken in this part of Africa, saving the Goualougo Triangle carries major significance. It enhances the possibility of preserving a very large expanse of continuous chimpanzee

To Goodall, each chimp has always been an individual, worthy of individual attention and concern—that is, in some sense a person.

Jane savors Goualougo's tranquillity. "It was the first time I've been in a forest that has never been lived in or logged," she says. "It was magic." Inspired by Jane's research at Gombe (one-eighth the size of Goualougo), Crickette and Dave (above right) plan to spend years tracking chimpanzees. A sniff of half-eaten stems tells them when the animals passed. Demonstrating behavior not yet seen in Goualougo, Jane shows how Gombe's chimps use sticks to extract ants from nests.

King of cool, a high-status male named Cole lounges at ease in the open. The first time he saw people, he threw them a backward glance and continued eating instead of fleeing into the trees. That calm acceptance led other chimps to relax around researchers.

habitat and, within it, a sizable interbreeding population of chimpanzees (thousands, rather than merely hundreds or dozens) into the next century and beyond. Securing such a single big area is crucial to the survival of the species, given that so many of Africa's other chimpanzee refuges are, like Gombe, far too small and too isolated to support viable populations.

The chimps of the Goualougo Triangle still enjoy the possibility of an unbounded and genetically robust future. That fact, in addition to their naive attitude toward humans, is what has made them such a focus of interest and concern. But can they *remain* so naive? If not, then what forms of chastening experience await them? Will they lose their ingenuous curiosity about humans by way of the intrusive attentions of ecotourism, rather than by the lethal traumas of hunting, habitat destruction, and beleaguered insularity? Such questions reflect the real distance—it's more than just land miles—between Gombe and Goualougo.

Naïveté is a delicate, perishable state of being, and in fact the Goualougo chimps have already begun to lose theirs. Although they haven't acquired any noticeable fear of humans, their curiosity seems less strong and impetuous than it was three years ago. The episodes of excited mutual ogling are less frequent. The limelight of continuous study, even by two such deferential scientists as Morgan and Sanz, seems to have jaded them slightly. The physicist Werner Heisenberg warned us about this: You can't observe anything closely without affecting it somehow.

On the evening of Jane Goodall's arrival at the Goualougo field camp, footsore and weary after a long day's slog, accompanied by Fay and a handful of others (including me), Morgan and Sanz were there to greet her. Night had fallen before the hiking was done, and we found our way down the last thigh-deep channel by headlamp. Stumbling up onto solid ground, we pitched our tents, washed, and reconvened at the campfire for beans and rice.

It's been ten years since she walked so far, Jane said. Her blistered soles reflected that fact. Still, at age 68, her signature ponytail now going gray, she had a reservoir of strength to spare—spiritual strength, if not muscular. She seemed invigorated by the sheer joy of being back in a forest full of chimpanzees.

Next morning Jane ventured out onto the Goualougo trails, hoping for a view of the animals Morgan and Sanz have been studying. But it wasn't like the solitary, early days at Gombe. Here, now, she moved at the center of an entourage: a Pygmy tracker, Morgan, Sanz, Fay, photographer Nichols with his unobtrusive little Leica—and that was just the half of it. With each step Jane took, a crew from National Geographic Television shadowed her, hungry to record every word and glance. The forest itself became a TV stage. But she was patient and professional, hitting her mark in every scene, repeating this or that comment when another take was called for, using the television attention as she uses all such burdens and opportunities of fame—to get her message out. That message, grossly compressed and presumptuously summarized, is: Every individual counts, both among nonhuman animals and among humanity, so if *you* renounce callous anthropocentrism and cruelty, your personal actions will make Earth a better place.

After five days in the forest it began to seem questionable whether Jane herself, the guest of honor, would have an extended encounter with any chimpanzees whatsoever. One problem was her damaged feet. Although the blisters didn't stop her from walking in the forest, they did inconvenience her. But she borrowed a roll of duct tape, for emergency foot maintenance, and carried on gamely. Another problem was the sheer collective bustle of such a large group. You don't parade through the woods in a party of ten if you want to see animals—not even if the animals in question are naive, or habituated, or flat-out deaf.

Finally, after most of a week, she did get a chance to enjoy what she had come for—three hours in the presence of a relaxed group of chimps as they fed, rested, and otherwise occupied themselves in a *Synsepalum* tree. It wasn't a dramatic encounter. The chimps went about their business, showing no excited curiosity or reciprocal fascination. But it was satisfying to Jane, who saw not just a gaggle of primates but individual creatures, particularized under the names by which Morgan and Sanz have come to know them—the female Maya, her infant daughter, Malia, the female O'Keefe, and a half dozen more.

Leaving the real thing behind, Jane carries out a toy monkey a sightless magician gave her years ago. "If a blind man can do magic, you can conquer the world," he told her. For Goualougo, Jane's hopes are benign: to preserve one of Earth's wild places and the animals within.

Later that afternoon Jane and I sat in the forest discussing the problems facing Gombe, her own years of experience there, and the prospects of an alternate future for the Goualougo. At one point I asked about the difference between concern for individual animals and concern for endangered, isolated populations. To her it's a sterile distinction. "When I'm thinking about some forest being logged, and the bush-meat trade," she said, "it isn't just a population of chimps that's going. It's individuals." Destroy individuals of such a species, and you eradicate also "all their wisdom, all their cultures that have been passed down from one generation to the next." After a moment, she added, "I can't separate the loss of a population from the harm to individuals." At Gombe she had known four generations intimately. To the extraordinary chimps of the Goualougo, she was a stranger. "It does take me back to my childhood dreams," Jane said. "You know, I'm really happy that I got here—in spite of the blisters!" Next morning, on nearly healed feet, she started walking back toward the world. □

WEBSITE EXCLUSIVE

Experience the Sights & Sounds of Megatransect—inspiration for the Goualougo preserve. Find a photo gallery and field notes at **nationalgeographic.com/ngm/0304.**

275 miles on foot through

A team of elite mountaineers sets out to witness birth at the calving grounds of the elusive Tibetan chiru.

By Rick Ridgeway
Photographs by Galen Rowell

Chang Tang

the remote

Hauling custom-built rickshas laden with supplies, our team—alpinists all—had to shift gears. On this trip, the point was not merely to face the challenge of nature but to help save a piece of it. Steep terrain, indeed.

This land is so desolate
that even the nomads of
western Tibet don't venture here.

COULD WE HAVE FOUND AN EARLIER WAY? Not really. A four-wheel-drive vehicle would get stuck in the mud out here, and engine noise would spook the chiru. By using lightweight rickshas, we didn't bottom out. I managed to muffle my grunting—mostly.

Two hours before dawn I zip open my tent door and peer out. The beam from my headlamp illuminates six inches of snow. Last night, when the ground was clear, my three companions and I decided to get an early start this morning. We wanted to pull our gear-laden aluminum rickshas as many miles as possible before the sun melted the hardpan into soft mud. Now it doesn't matter: Pulling through snow will be just as difficult. I remind myself that tenacity is easier when you have no choice.

As I maneuver out of my warm bag and into my cold pants, I consider the work in front of us. We are five days into a thirty-day trek across Tibet's northern Chang Tang, a vast alpine steppe so

sparsely populated we don't expect to see another human being for more than 200 miles. This land is so desolate and high—the average elevation above 16,000 feet—that even the *drokpa*, the leather-skinned nomads of western Tibet, don't venture here. The animals are so unaccustomed to people that on the second day of our trek a wolf came within 50 feet and stared at us for 20 minutes.

By dawn we are each straining against the waist harnesses strapped to our rickshas, our wheels tracing deep furrows in the virgin snow. We have left the flat steppe and are pulling our rickshas up the foothill of an unnamed 20,000-foot peak north of Toze Kangri mountain. As the sky brightens, a snow finch sounds a morning chirp and the sun feathers through a reef of clouds. Behind us the slanting rays paint the snow-blanketed hills pink. Ahead the early light disperses through an icy haze into a long band of purple, green, yellow, and red.

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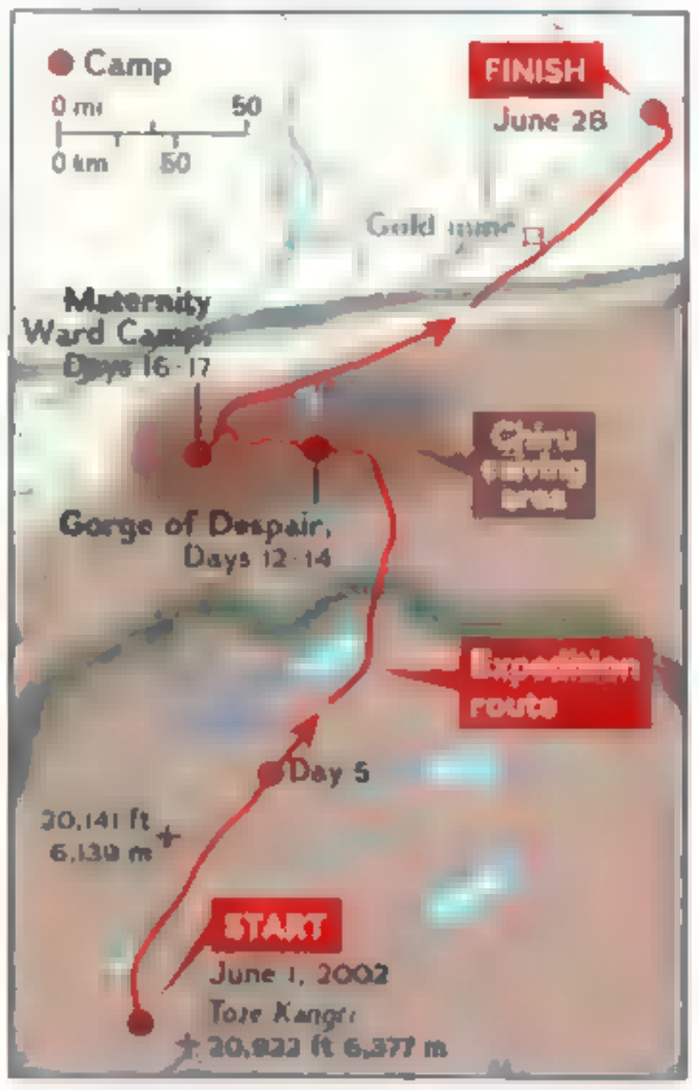
"A circumhorizontal rainbow," Galen says. "You see it in high mountains and polar areas every once in awhile."

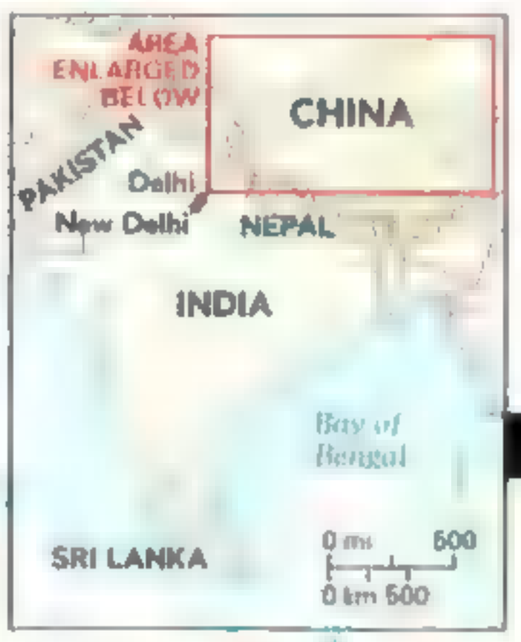
Best known as a photographer and mountaineer, Galen Rowell is famous among his friends as a font of information about the wilderness. Earlier, in his outdoor professor mode, he made us stop to examine an arenaria, a cushion plant that looks like an overcooked extra-large pizza. Later he gave us a mini-lecture on frost polygons—mounds of earth heaved up like gopher trails and frozen into geometric shapes. What none of us can imagine on this crisp morning is that this would be Galen's last expedition: A month after we returned to the United States, he and his wife, Barbara, perished in a plane crash near their home in Bishop, California. In the sad days following his death we would find solace in the knowledge that for all of us, including Galen, this adventure had been among the most fulfilling of our lives.

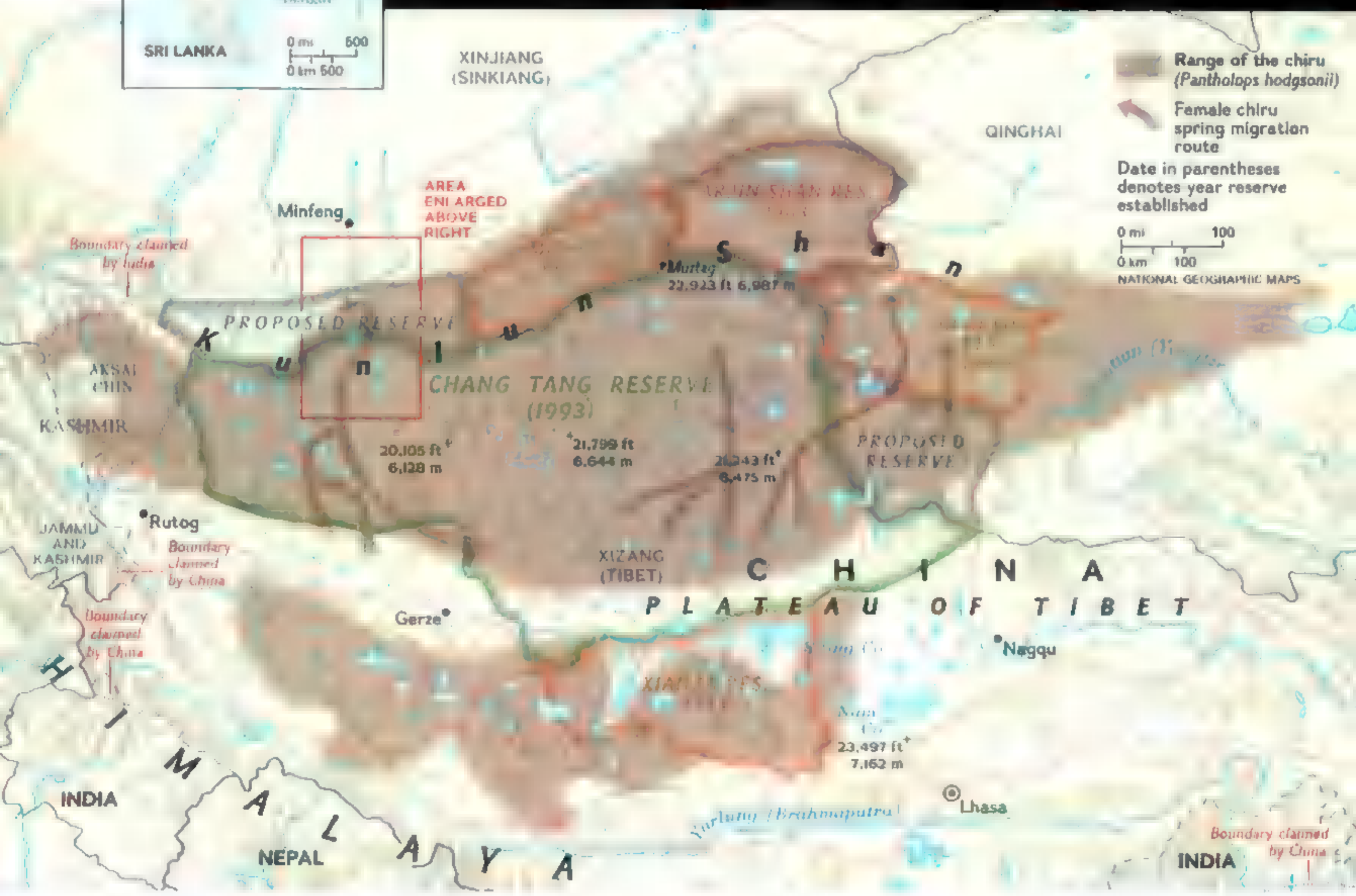
SOFT WOOL, HARD CASH **Poached for its delicate pelt, the chiru, or Tibetan antelope, is now endangered. While females walk nearly 200 miles north to their calving grounds, horned males wait behind (below).**

Tailing a Herd

We had never seen this terrain before, but we didn't come here blind. George Schaller, a world-renowned wildlife biologist, has been studying the chiru for 15 years, and lobbying for their protection. In 2001, trekking south from China's Xinjiang Autonomous Region, he found a concentration of pregnant females, but was unable to wait for the births. Now, with Schaller's notes in hand, we hoped to confirm that location as the calving grounds of Tibet's western chiru herd. We knew that migrating females would converge near Toze Kangri (map at left), so that's where our five-day drive from Lhasa, Tibet, ended, and where our foot safari began (right). Two of the team (bottom right)—Conrad Anker, in blue, and Jimmy Chin—assembled our aluminum rickshas, designed to carry more than 200 pounds of gear (including four celebratory cans of beer).







We started our journey on May 27 in Lhasa, capital of the Tibetan Autonomous Region of China, where Conrad Anker, Jimmy Chin, Galen, and I hired a four-wheel-drive SUV and a double-wheeled truck, and bought six drums of fuel. With a staff of four Tibetans—two drivers, a cook, and a liaison officer—we drove north for five days, first over rough dirt roads, then for three days following the faint tire imprints of the infrequent vehicles that had preceded us. Finally we reached a point where the tracks vanished into the muck and our trucks could go no farther.

We have come to the Chang Tang on a conservation mission: To locate herds of Tibetan antelope, called chiru, and follow females on their annual migration to calving grounds somewhere in the remote Kunlun mountains to the north. The Chang Tang still harbors many of the wild animals that once roamed widely across the rest of Tibet, including wild yak, kiang (the Tibetan wild ass), Tibetan brown bear, Tibetan argali sheep, Tibetan gazelle, and the largest of Tibet's four populations of chiru, which have come under attack by poachers. (See "Drop Dead Gorgeous," page 124.) Since 1983 the Chinese government has set aside more than 190,000 square miles of the Chang Tang—"northern plain," in Tibetan—as protected areas. Our goal was to document the chiru calving grounds on film and video, so the acclaimed wildlife biologist George Schaller and his associates at the Wildlife Conservation Society could use our data to persuade the Chinese to expand the preserve to encompass that critical area.

Now, on this fifth day of our trek, our concern is not so much being slowed by six inches of snow, but rather that so far we still haven't seen any chiru; that is, we have seen only a few groups of ten to twenty, not the long procession of animals walking in deep grooves of an age-old migration track that Schaller had told us we were likely to encounter. Has the migration already passed? Or has the migration route shifted since Schaller's last visit? Or worse, has the poaching been so severe that now only a handful of chiru survive to make the trek?

By two in the afternoon the snow is gone, and Galen hypothesizes that much of it has sublimated into the dry air. Our altimeter reads 17,000 feet. Two days south of Heishi Beihu, or "blackrock northlake," we have left the foothills and are crossing an utterly flat steppe we call "Kansas." In the distance a rain squall moves like a dark curtain across a stage and the horizon shimmers through heat waves.

Suddenly Jimmy Chin stops in his tracks. "Animals! Hundreds of them," he shouts. Just as excited, I raise my binoculars, but when I bring the "animals" into focus I see instead dozens of rocks distorted by air convections, moving as though they were alive. Jimmy takes the bad news with a bemused grin. At 28, he is young enough to be a son to Galen or me, but he is already our peer in mental strength and resilience. He has a built-in curiosity and sense of humor. "I'm looking forward to learning from

SNOW GOING **With only 30 days' worth of supplies on board, we didn't have the luxury to sit out this storm. So, like sled dogs, we mushed on. Mounting all-weather balloon tires was more hassle than help, even as the snow melted into a foot-sucking bog of mud.**

I remind myself that tenacity is easier when you have no choice.

the old goats on this expedition," he told us at the start. "I mean, from my mentors."

The next day we continue to cross the steppe, stopping at the base of a basalt ridge for an early lunch: a small packet of nuts, dried fruit, jerky, and an energy bar. It's the same thing we had yesterday and the same thing we'll have tomorrow. Each day we're expending more calories than we're eating, and our bodies are thinning. But we can't carry any more weight. At the outset each ricksha weighed between 250 and 275 pounds fully loaded, including water for three days in case we have trouble finding streams or springs.

Now we climb the ridge, and each step requires a weightlifter's leg-press to move the carts. We are heading toward what I pray will be the pass through the ridge when we see eight female chiru. Does that mean we're near the migration route? When we reach what looked like a pass, however, there is only a slight dip and then a long hill leading to another "pass"; when we reach it, not only is there another one still higher, but just as disappointing we find only scattered chiru tracks.

I've developed a persistent cough by now and my lungs have begun to ache. I stop to rest, but this only increases the gap between the others and me, and I have to work even harder to catch up. When we reach the final pass, my legs are cramped, and I worry whether, at age 52, I will be able to go the distance after all. We choose a campsite nestled between basaltic boulders, unbuckle ourselves from our carts, and walk toward a rock ridge we hope will allow us a view.

As we near the crest, Galen motions us to be quiet. We crab-crawl until we can peer into a valley bordered by low-angled hills covered in pale yellow grass, and there before us we see at least 70 grazing female chiru. My fatigue dissolves as I watch another dozen animals appear on the opposite ridge, skylighted before they drop into the valley to join what is clearly the main migration route.

We throw our arms around each other: We found it!

JIMMY CHIN

Walking at last with the chiru along the icy shore of Heishi Beihu, we feel confident now that we can follow them to their calving grounds. The animals are skittish, but if we stalk them slowly, we can sometimes get close enough to see the white markings on the inside of their alert ears, the dark eyes framing their pug snouts, the sheepskin texture of their fawn coats covering the bulge of their bellies.

As we pull our heavy carts, we empathize with the pregnant females on their nearly 200-mile migration. Why do the chiru do it? Not for grass and browse; that's more abundant in the southern part of their range than here. There may be fewer predators here in the north, but the stress of such a long migration probably outweighs that benefit. George Schaller believes the migration may be a vestigial behavior tied to a time when it was "nutritionally adaptive" for females to move north. Pollen profiles and ancient shorelines suggest that 5,000 to 13,000 years ago the Chang Tang was relatively lush.

For us the mystery makes the migration even more compelling. For two days we follow the chiru northward, crossing the border into Xinjiang and leaving the animals' safe haven in the Chang Tang Reserve. Mile after mile as I pull my ricksha, I play Ravel's "Bolero" over and over in my mind. Germans call this an "ear-worm"—when you have a song stuck in your head—but this worm doesn't bother me: "Bolero" seems perfect for pulling carts at 17,000 feet across Central Asia. In the distance I see chiru going the same direction, at the same speed. We are two different animals, one migrating, one trekking.

On the 12th day of our trek the single migration scatters in multiple tracks across a snowy plateau, but all hoofprints point toward a ridge of low hills. We follow what on our topographical map appears to be a moderate passage through the hills toward the Shar Kul basin. We find the prints of about a hundred chiru frozen in mud and outlined by drifting snow. But now we are less concerned whether they are leading us to their calving grounds than whether we are following them into a dangerous canyon.

Instead of mud and gravel bars we are now pulling our carts over sofa-size river rocks. Even though it's downhill, it's hard work: Each time the wheels hit rocks we have to triple-team each cart over—one pulling, while two push. All of us are listening to the caution buzzer in our heads. Will the canyon become impassable, forcing us to reverse course? If it does, we could run out of food.

Conrad scrambles to the canyon's rim to scout for an alternate route. But when he comes back, he reports seeing a series of steep hills he judges more difficult to traverse than staying in the canyon. We all know his judgment is sound: In 1999 Conrad succeeded in doing what many believed impossible, finding the body of famed British climber George Mallory high on Mount Everest. We trudge on, fighting for each yard. By day's end we have traveled less than two miles.

Each day we're expending more calories than we're eating, and our bodies are thinning.

BONE TIRED **I've climbed some major mountains, including K2, but the Chang Tang drained me (left, at left) and my teammates. Maybe it was the thin air at 17,000 feet. Maybe it was the long miles. Or maybe it was the donkey skeleton (right)—likely a casualty from Schaller's 2001 trek, and a vivid reminder that if we ran out of food, we were cooked.**

We crab-crawl until we can peer into a valley, and there we see at least

70 grazing female chiru.

My fatigue dissolves.

MATERNITY MARCH

On day six of our trek we finally crossed paths with a small caravan of chiru bound for their calving grounds. Around 1900 nearly a million Tibetan antelope roamed; by 1995 demand for fashionable chiru wool had dropped their numbers to perhaps 75,000.

The following day, as we round each bend, we pray the gorge will widen. Instead, at each turn it narrows. We pull the carts through the icy stream, our feet turning numb. At one point the walls of the gorge squeeze down to only ten feet apart for more than 50 yards. Suddenly we hear a loud *Whumpf!* as a basketball-size rock smashes into the streambed 20 feet away. With the warming sun, there's sure to be more rock fall. Conrad takes out his pocket notebook that holds a photograph of his wife, Jenny, and their three boys, and in the manner that Tibetan Buddhists venerate sacred objects while praying for good fortune, holds it to his forehead for several seconds.

When we stop to rest an hour later, I discover my wheel frame has two cracked welds. Conrad has four cracked welds. Jimmy has one weld broken through. We have no choice but to portage our supplies, then carry the empty carts over the bigger rocks. We load our backpacks until each one weighs 60 pounds or more; even then it takes two shuttles.

In midafternoon we see a well-worn trail climbing out of the canyon. It must be the path the chiru are taking toward their calving grounds. But the hillside is steep, and we would have to use ropes to get the carts up. We decide to stay in the canyon and search for the chiru later. It is nearly 6 p.m. by the time we find a small bench 15 feet above the river. Conrad suggests we camp, but Galen points out that we still have four hours of daylight, enough time to get out of the gorge. Otherwise we risk getting caught in a flash flood, he says. I counter that with fatigue we run a greater risk of spraining an ankle. Galen disagrees but suggests he scout ahead while the rest of us finish the portage. Soon he is back.

"There's one more narrows," he says. "It will be hard with the carts, but we can definitely get out." I hold firm to my opinion, and Conrad and Jimmy both agree with me.

"I'll go with the majority," Galen says, "but I'm going to portage my camera gear and film out of here today."

"Why don't you do it in the morning," I suggest. "Rest up so you're fresh."

"Because I don't think it will be safe in the morning."

HOME-FIELD ADVANTAGE **Chiru are nimble and can run as fast as 35 miles an hour. They are also very sensitive to human movements, so while in pursuit we kept a low, often awkward, profile. On days 12, 13, and 14 we got stuck in a slot canyon. To avoid damaging our carts, we carefully lifted them over the rocks, but the welded joints began cracking anyway. Welcome to our Gorge of Despair.**

I watch Galen disappear down the gorge, amazed at how he can push himself, even as the rest of us are calling it a day. But I know he has no secret, only passion, enthusiasm, and willpower. In the morning Conrad unzips our door to tell Galen and me that coffee has been ready for a half hour. We hadn't heard him over the sound of the river.

"It came up during the night," Conrad says. "It's nearly twice as high as yesterday."

I can see he's concerned, and I also read in his expression the acknowledgement that Galen was right. It takes us until midday to complete the

shuttle, but finally we escape into the broad Shar Kul basin. We spend another hour reinforcing the carts with tape and wire. "Let's see if this works," Conrad says. No one suggests what we will do if it doesn't.

Next day we search for where the chiru were heading when they left the gorge. Once again we enter the hills, but this time we find a valley that is easy to ascend. We feel even luckier when we begin to see chiru, at first groups of 20 to 30, then a herd of 130 animals, so many they make the slope appear to shift like wind blowing across hillsides of wheat. By midafternoon we arrive at a high plain and park our carts. With my binoculars I scan foothills to the west, bringing into focus what look like scores of rocks peppering the hillsides. They shimmer in the heat waves as suddenly one rock, then another and another, moves in a slow amble.

"The hills are covered!" I yell to the others. Covered with hundreds of chiru.

We have found the calving grounds at last. In one sweep of the eye, we count 1,300 animals. In the larger area, we estimate there may be another 3,500. To complete our main objective, we must now document their birthing on film and video. We set up what we call Maternity Ward Camp and reassess our food supply. We have only enough to stay for two days, so we have to make each hour count. To get close enough for good shots, Galen reminds us to approach the chiru slowly and quietly, using hills and gullies for cover.

The following morning, to minimize our presence, Conrad and I stay hidden, while Galen and Jimmy, draped with camouflage netting and cameras in hand, stalk up a ravine. Soon they are inching forward on knees and elbows toward a crest where earlier we had spotted a herd of chiru. If the animals are still there, will they have their young? Galen and Jimmy drop to a belly crawl, and as they peer over the crest, they see the herd quietly grazing. They are all pregnant females—except one with a newborn suckling! The mother moves away a few feet, and while Jimmy and Galen's cameras hum and whir, the fledgling totters on skinny legs back to its mother.

In the weeks they spend in this remote sanctuary, they can birth their young unconcerned about poachers.

CONFIRMED DELIVERY **We spotted this day-old calf, its mother nearby, not far from some 1,300 browsing and birthing chiru (right). This is the first photographic proof of a calving ground northwest of the Chang Tang Reserve. Why the mothers migrate here, where forage is thin, is a mystery. But this much we know: To save the chiru, we must safeguard this wild nursery.**

A day later, alone on a hillside, I watch a herd of 18 pregnant females, their bellies bulging, and behind them a single mother with a tiny calf. They don't see me, but they raise their heads in the direction where an hour earlier I had seen a large wolf. The chiru remain wary of such natural enemies, but at least for the few weeks they are here they can birth their young unconcerned about poachers. Elsewhere in China hunters may claim as many as 20,000 chiru a year. With as few as 75,000 chiru left in the world, that will spell disaster if unchecked. The Chinese have made a valiant effort to control poaching in the preserves, but the challenge must be met by everyone in the chiru wool trade, including those who make poaching profitable by purchasing expensive chiru wool shawls.

Having found the calving grounds and documented the chiru babies, we have achieved what we set out to do. But we still have a hundred miles to walk to reach our rendezvous with civilization: a roadhead where a vehicle will be waiting. We are three days from that meeting place when suddenly civilization comes to us. Rounding a bend, we see what appears to be a large mine. Through my binoculars I spot fresh tailings, bulldozers, a crane, and dozens of people, where only a year before George Schaller had found wilderness.

The miners are friendly, offering us food and tea. More than a hundred of them are working a placer operation they hope will yield 2.8 million ounces of gold. They are proud of what they have accomplished in less than three months, including the construction of a 60-mile dirt road from the nearest highway.

That same dirt road gives us an easy way home, as we cart toward our waiting vehicle. But it could also give poachers easy access to the calving grounds. From the mine we estimate a four-wheel-drive vehicle could make it cross-country in two days—disheartening when we consider that from the other direction it took us more than a month by truck and on foot. With the chiru's calving grounds suddenly vulnerable, we feel a new urgency to report our findings.

Two days later we reach the first village we have seen in over 400 miles. I glance into the side mirror of the vehicle that will take us toward home and discover that I look as grizzled as I feel—and so do Jimmy, Conrad, and Galen. Our hosts fete us with crisp watermelon and cold drinks, but as I look back now, months later, that happy moment feels bittersweet, framed as it is by Galen's loss. We can only hope that our efforts will make a difference for the chiru—that the wild animals we came to admire will be given the space and solace they deserve.

WEBSITE EXCLUSIVE

Watch excerpts from the documentary shot by the expedition team and zoom in on a photo gallery by Galen Rowell at **nationalgeographic.com/ngm/0304.**

ONE STEPPE BACK
Trudging to the finish, our big challenge was finding water. Then we spied a tougher one: A gold mine had opened nearby, with a new road that would make chiru poaching easier. Our mission, we realized, had only just begun. ▯

We are three days from that meeting place when suddenly civilization comes to us.

Drop Dead Gorgeous

Why poachers are killing the chiru

By George B. Schaller

I was studying the wildlife of China's remote Tibetan Plateau in 1991 when I came upon a hunters' camp. There outside a tent I found a pile of 22 blood-red carcasses stacked like cordwood, the ten-day booty of three men who had traveled 130 miles from the nearest town to hunt Tibetan antelope, or chiru, with leghold traps. Elsewhere I heard of truck drivers, officials, and military men shooting chiru from vehicles with high-powered rifles just for the hides.

Earlier I had seen traders plucking wool from chiru hides and stuffing it into sacks in the town of Gerze. Nepalese and Tibetan middlemen were smuggling the wool to the Indian state of Jammu and Kashmir—a wholly illegal trade because the chiru is considered an endangered species by international convention, one signed by most countries, including China, Nepal, and India.

A year later I received a letter at the Wildlife Conservation Society from Michael Sautman, president of the California Cashmere Co., Inc., asking me about a rare wool called *shahtoosh*. Sautman noted that the wool came mainly from Tibet and that it was said to be derived from a wild goat, *Capra ibex*. I had never heard of shahtoosh, but knew that few if any ibex could be found in Tibet. I also knew that chiru were being massacred for their wool. Sautman and I came to an inescapable conclusion: Shahtoosh wool came from the endangered chiru.

Shawls woven from shahtoosh, or "king of wool" in Persian, had been highly prized for a thousand years or more. Indians, particularly in Punjab state, once coveted a shahtoosh shawl as part of a dowry and family heirloom, calling it a ring shawl because it was so fine that it could easily be pulled through a wedding ring.

Kashmiri traders and weavers guarded the secret source of shahtoosh. Some claimed it consisted of the belly hairs of ibex or down from the "Siberian goose." Pulling the wool over their customers' eyes, they spun a yarn that claimed nomads painstakingly collected the silken-soft wisps of shed wool from bushes.

Only Kashmiri weavers knew how to process the short, gossamer fibers. In a home industry, women separated coarse guard hairs from the wool fibers to make yarn on manual spinning wheels. Men then washed this yarn and wove it into shawls, a slow process that could take ten days to produce a typical lady's shawl about three feet wide and six feet long. Such a shawl was feather-light, weighing a mere four ounces. Beautifully embroidered ones could sell for as much as $15,000 in London or New York.

By the late 1980s the international market for shahtoosh was insatiable and the great chiru slaughter began. In 1993 one poaching team was arrested with more than 1,300 hides. In 1999 an antipoaching sweep netted 66 poachers, 18 vehicles, and 1,658 hides. By 2001 China's State Forestry Administration had confiscated more than 20,000 hides and 38,800 ounces of wool, which, at four to five ounces per animal, translated into an additional 9,000 chiru.

Of course only a small fraction of loot was

intercepted before leaving the country. China estimated that as many as 20,000 chiru a year were being killed. When I was asked by Chinese authorities to help publicize the species' plight in 1992, I contacted, among others, Belinda Wright and Ashok Kumar of the Wildlife Protection Society of India. Their undercover work, together with that of the local police, led to the prosecution of several Delhi shawl dealers and by the end of 2000 to the seizure of 606 shawls.

Although I raised the issue of chiru poaching in a NATIONAL GEOGRAPHIC article in August 1993, awareness of the problem seeped only slowly into public perception. The fashion magazine *Harper's Bazaar* advertised a $2,850 shahtoosh shawl in its June 1998 issue, and British *Vogue* promoted the wearing of such shawls as one of the "survival tactics" at dull parties in its June 1999 issue. That same month a subpoena by a New Jersey grand jury ordered a number of New York "fashion icons" to testify. On hearing that everyone was encouraged to turn their shawls in to the U.S. Fish and Wildlife Service, one socialite exclaimed in a November 1999 *Vanity Fair* article: "I haven't heard anything so ridiculous in a long time. Some of our friends will have to call a moving van."

GEORGE B. SCHALLER

Sensually soft *shahtoosh*—finer even than cashmere—doesn't come cheap. Three to five chiru must die to produce the wool required to weave a single shawl.

By then the death of chiru as fashion victims was finally receiving worldwide attention. Conservation groups promoted protection of the chiru; China hosted an international workshop on control of the shahtoosh trade. *Time* and *People* carried stories about the problem. But the illegal trade in shawls remained rampant.

The weaving of shawls in Kashmir obviously had to stop. The Wildlife Protection Society of India had sued in 1998 to force the government of Jammu and Kashmir to uphold India's international agreements, and two years later it won its case in the Kashmir High Court. At the time, Chief Minister Farooq Abdullah of Kashmir vowed that "shahtoosh will be banned in Kashmir over my dead body." But in May 2002 the state passed a law banning the trade.

The fact is, the shahtoosh industry is bound to collapse within a few years as chiru populations in China are reduced to scattered remnants, and the wool spinners, weavers, dyers, and others involved in Kashmir return to processing mainly goat cashmere. A century ago at least a million chiru probably roamed the uplands. By the mid-1990s possibly no more than 75,000 remained.

During our years of studying chiru in the Chang Tang, we learned that there are four main populations, and that each May the females of the largest population begin a long trek northward from Tibet into Xinjiang. In 2001 Xinjiang established the Mid-Kunlun Reserve adjacent to Tibet's huge Chang Tang Reserve, but the boundary stopped well short of the calving ground. Our hope is that Xinjiang will now protect that too.

In 2001 we were finally able to locate the place where the females of the main population give birth in the most remote corner of the Tibetan Plateau, but we arrived before calving began. So I was delighted to learn that four mountaineers had applied their skills to a conservation mission to confirm the migration route (map, page 110) and witness chiru births. These newborns offer hope for the future of the species and a challenge to the Chinese government to protect them from poachers. □

AUGUSTA, GEORGIA

30904

Playing the Fairway

BY RALPH WILEY PHOTOGRAPHS BY JONATHAN ERNST

Golf put Augusta on the map. Controversy keeps it in the headlines. Forced by the sport's governing body to admit black members in 1990, Augusta National Golf Club has lately caught heat for excluding women. The club hosts the Masters Tournament, an occasion to dine alfresco (below). "Golf's my passion," said Butch Littles (left, in shades), once a coveted caddie at Augusta and a near-par player on the senior tour. Weekend warriors hit on humbler links at Augusta Country Club (below left).

AUGUSTA, GEORGIA

Yes, white pineapples. Some made of stucco, a few of stone, but mostly just painted pine, mounted on walls, gates, and fences in front of the big houses along airy Walton Way, on the northwest, upland side of Augusta, Georgia. Up above Augusta National Golf Club, where the Masters is held every April. They are a traditional sign of welcome. (The pineapples, that is.)

There are no pineapples outside Augusta National's green-and-white brick facade. One must be invited in there. Such invitations are hard to come by. It was 1990 before the club admitted a black member. And a dispute about whether to admit women to the 300-member club became a controversy beginning last summer.

Things are less exclusive a few blocks over at the Augusta Municipal Golf Course, a small public acreage run by the Augusta Department of Recreation and Parks. Augusta Municipal, known locally as the Patch, is a mundane infield compared with the Masters track, where color-burst flora (over the years 80,000 plants of 350 varieties) floats upon a sea of chlorophyll green, an endless cumulus cloud mattress of the richest grass. The Masters is played in a world inside a world unto itself, framed by azalea, redbud, holly, dogwood, juniper, jasmine, nandina. By contrast, the Patch is just a small, forgettable muni.

Each is in zip 30904, equal in that, if nothing else. Quietly, there seems to be plenty of else. In the "Garden City," as in Joyce's Dublin, history is a nightmare from which the residents are trying to awake. On Broad Street downtown, the Confederate Memorial stone monument bears a plaque:

A badge, or pass, can net $10,000 for scalpers profiting on public hunger to enter the gates of the tournament. A volunteer (below) sweats for the honor of grooming bunkers during Masters week.

30904

POPULATION OF ZIP CODE: 28,300
MASTERS LONGEST HOLE: No. 2 (aka Pink Dogwood), 575 yards
CITY POPULATION: 198,000
PERCENT BLACK: 50
PERCENT WHITE: 46
CITY ORIGINS: Founded 1735. State's oldest after Savannah
HOTELS: 6,000 rooms
Occupancy: 63% on average; 100% during Masters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"No Nation Rose So White and Fair, None Feli So Pure of Crime." Since its inception in 1934, the Masters has symbolized a peculiar blend of nostalgia and revulsion, priding itself on not just its prejudice but also its ability to bend local wills to accept it as natural. A Masters Tournament badge, allowing all access to the grounds, remains expensive, hard to get. Yet today the Masters is a commercial engine for Augustans of all stripe, both native and foreign-born, east Indian expatriate motel owners to Italian restaurant managers.

Wealthy planters and big-city financiers came here to escape winter up north or yellow fever to the south.

Well within walking distance of Augusta National, no fast-food or commercial pop culture touchstone is left unturned. Krispy Kreme exists, Hooters too. In quaint, conservative Augusta you get the feeling that Man, for all his great feats and fatal flaws, is basically a party animal in need of fast redemption.

A middle-aged black man named Jarvis Mims, driving a hotel shuttle van, gives me a discarded, but still valid, $21 badge to a Masters practice round and offers to drive me in to Augusta National, then pick me up in three hours, on his regular run, after I see how impossibly green the course is. He's as nice as pineapples, waving a hand callused by 30 years of back-breaking manual labor at the old textile mill near the downtown flats and Savannah River.

A blond teenager gabs as she takes in cash to direct cars on a lot near the grounds. "Got 108 in today," she says. "Money's for my college fund."

Inside Augusta National's green-and-white brick walls, spectators traverse the course en masse, as if in human ant trails, moving double, triple, quadruple file, over the emerald lushness; roars come in distant waves from far-off holes. The trails also march into the clubhouse area and Founders Circle, up by Butler Cabin, in and out of the golf shop selling memorabilia. The course is dotted by discreet green plastic trash bag stands. The bags are fairly unnoticeable, except for the striking block letters they bear: PLEASE PLEASE PLEASE.

Make that *Mister* "Please Please Please" himself, the Godfather of Soul, James Brown, the rhythm and blues icon who grew up here and now has a downtown Augusta boulevard named for him. To divine more about Augusta, I head down James Brown Boulevard with Lourdes D'Arcy Neely Coleman. Her father, Clement Neely, a black Korean War veteran, waited tables at the Bon Air Hotel on Walton Way. Wealthy planters from Charleston or Savannah and big-city financiers came here to escape winter up north or yellow fever to the south. They needed dependable service. Thus the Neelys persevered. Lourdes put herself through Augusta College, then law school.

Now Lourdes is home to practice law after a career away from Augusta. She drives in the downtown flats, quietly marveling that the same place could produce the Masters, President Woodrow Wilson, the Godfather of Soul, and the Patch. She points out a modest brick pillbox law office

A Masters cap tops Jeff Davis at Augusta's municipal course (left), where Isaac Arnold practices putts (below). Players irritated by noise occasionally lob shots to try to hit private planes landing at Daniel Field, buzzing with air traffic during Masters week.

On the way to school, Marquis Kendrick stops for breakfast at a café owned by his grandmother, Willie "Miss E" Brewer. A caddie mural adorns the outside. Her heroes—Mandela, King, and Malcolm X—are enshrined inside. "I told Marquis that when his generation comes up with three heroes, I'll put their pictures up."

she rents from a white real estate appraiser, Jack Minor, Sr. "Over there is the Jessye B. Norman Amphitheater, by the river . . . beautiful . . . and look, it's the new school of fine arts," she says with pride, driving by a modern red brick edifice on 12th Street near Telfair. The school is a public magnet school, one of the best in the state, with an equal number of black and white students.

Score another victory over absurdity, par for today's Augusta.

A tournament badge for the four-day Masters is worth whatever the market will bear, thousands of dollars. But on the opening day of the Masters, it costs only $28 to *play* 18 holes at the Patch. As Lourdes and I arrive, we see golfers on the course ducking as a Cessna on approach buzzes overhead. Probably carrying Masters customers. The ducking is understandable, as one green sits beneath a landing pattern to the airport next door.

One group playing the Patch is made up of the Smiths, father Jimmy and grown sons, Greg and Jerome. Jimmy was once stationed at nearby Fort Gordon. Jerome works at the Castleberry Foods plant, a primary blue-collar employer along with the Sweetheart paper cup factory. "We would've had to get dressed up to go to the National just to see a practice round," he says.

"Up to the early sixties, black folks couldn't play the Patch, either," says a graying Richard Marshall. "Took agitatin'."

Richard is doing all the talking between him and Charlie Choice. "We caddied at the National. All kinds of golf courses around here," Richard says. "Forest Hills, Three Oaks. Did we ever *play* Augusta National? Yep. Weren't supposed to. Evenings, near dark, after caddying, we played. Learned how. Heard of Jim Dent? From here. Ex-caddie. Used to be eight to ten black American golfers on tour. Now it's just Tiger Woods."

People in zip 30904, surrounding Augusta National Golf Club and the Patch, aren't all that much on the high-hat anymore, no matter what persuasion of head happens to be under it. Old paradigms are being subtly transmuted, a social alchemy that makes Augusta novel, in its own quiet, deceptive way. □

She marveled that the same place could produce Woodrow Wilson, the Godfather of Soul, and the Patch.

WEBSITE EXCLUSIVE

There's more on 30904 at **nationalgeographic.com/ngm/0304**.

Final Edit

JANE IN THE FOREST AGAIN

Rain, Rain, Go Away

"This is one of my favorite pictures from the shoot," says photographer Michael "Nick" Nichols. He captured Jane Goodall and Pygmy trackers Mbio and Koba as they waited out a storm beneath a high-canopied tree in Congo's Goualougo Triangle, where storms can last for hours during the rainy season.

While she waited, Goodall says she couldn't shake an awful thought: "If loggers came to this ancient, peaceful place, this tree that's taken hundreds of years to grow would be cut down in ten minutes."

That moment of musing provided an opportunity for Nichols, who had been holding an umbrella for Goodall until he stepped back to take the picture. "She's such a strong person, a crusader, but here she looks vulnerable. I like it because it shows a side of Jane we don't usually see."

WEBSITE EXCLUSIVE

Cut it or keep it? Find out what tipped the balance for this photo at **nationalgeographic.com/ngm/0304**.

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Praise for a Trailblazer

Photographer Galen Rowell (1940-2002)

CAVES OF OMAN

Fear Factor

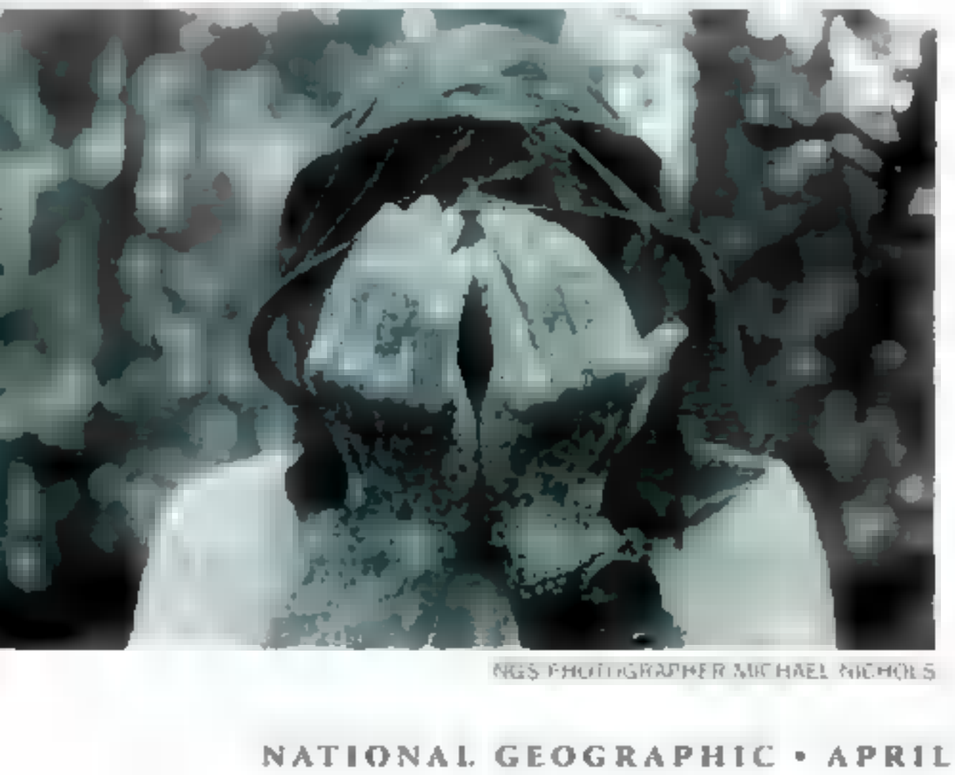
Climber Goes Underground

Author **Greg Crouch** isn't afraid of heights; he's climbed mountains around the world for 17 years. But going underground in Oman—his first foray into "hard-core vertical caving"—was unnerving. "The darkness scared me," Greg says. "When you rappel, you're not always next to the wall like you are when you're climbing. And I was afraid of being stuck in some tight, dark place." He never got stuck, but he did get wet while wading between caves called 7th Hole and Kahf Tahry (right). In another cave he had to swim about 60 yards ("sort of a dog paddle")—not the easiest thing to do in caving gear.

STEPHEN L. ALVAREZ

WORLDWIDE

Ten years ago, when photographer **Michael "Nick" Nichols** first worked in Africa's Goualougo Triangle, he was plagued by hordes of stingless bees attracted to his sweat. When he returned for this month's article and set up cameras to photograph a termite mound, he came prepared: He brought a hat with netting (below). "The bees don't hurt you, but they're a nuisance," Nick says. "You lose them if you start walking, but when you're sitting in one place making pictures, you just endure it. And I learned early on that if you kill one of them, all their friends come."



NGS PHOTOGRAPHER MICHAEL NICHOLS

It started as a routine day's shoot, photographing mountains near the Corsican town of Bonifacio from the air. But then **Bruno Barbey**'s chartered helicopter developed engine trouble. Fortunately, his pilot stayed calm. "He looked for a flat place to land, and he found a small beach half a mile away, at the edge of the water," Bruno recalls. "We landed, then the helicopter tumbled on its side. I had no time to be afraid. Only later did I realize that I had a one-in-two chance of being killed." The only casualties, other than the chopper: two rolls of film.

Author **Peter Ross Range** had a different kind of brush with mortality in Corsica. "On my third day there I was interviewing the island's police chief, and he told me of a mafioso named François Santoni who was willing to talk about the violence in Corsica," Peter says. "The next morning, French television went live with news of another Corsican murder. And the victim was Santoni!"

After a while Peter developed a native's indifference. "Violence is just part of the air Corsicans breathe. The local mafia only shoot each other or occasionally government officials. And when they blow up a bank, they do it at one in the morning so nobody gets hurt."

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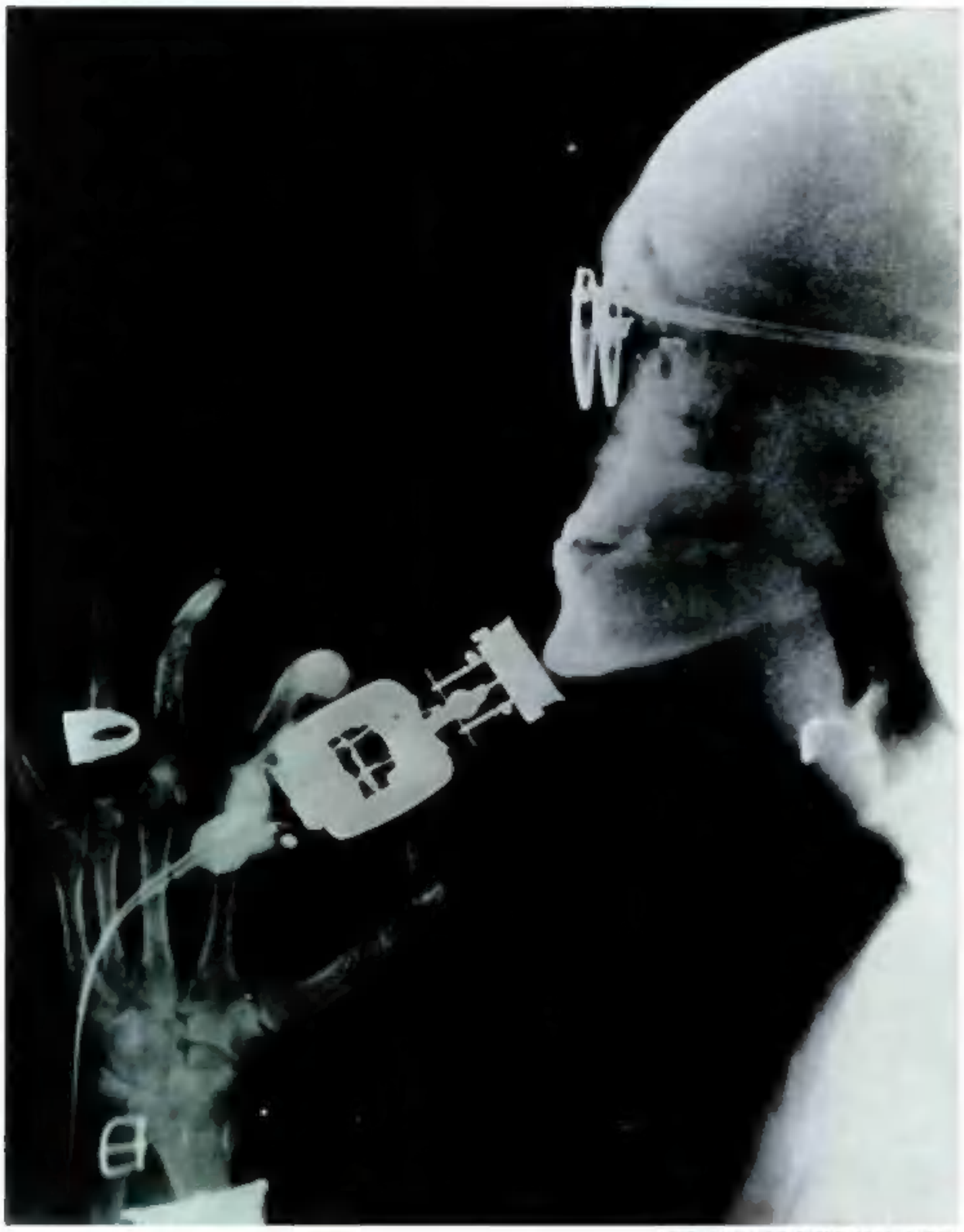

WESTINGHOUSE ELECTRIC CORPORATION

THE RISE OF MAMMALS

Taking It on the Chin

Hair is one of the characteristics that set mammals apart from other animals. Even whales and naked mole rats have some.

Humans don't have as much hair as most mammals, but many people would prefer even less. The Gillette Company reports that, on average, American men shave an area of 48 square inches 24 times a month, while women shave 412 square inches of their bodies 11 times a month.

In 1941 Westinghouse demonstrated x-ray technology with this image of a man shaving with an electric razor. It has never before been published in NATIONAL GEOGRAPHIC.

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You can send this month's Flashback as an electronic greeting card and access the Flashback photo archives at ***nationalgeographic.com/ngm/flashback/0304.***

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Alarm clocks
School buses
8am meetings
spilled coffee

Life is a contact sport. Not playing is not an option.[SM]

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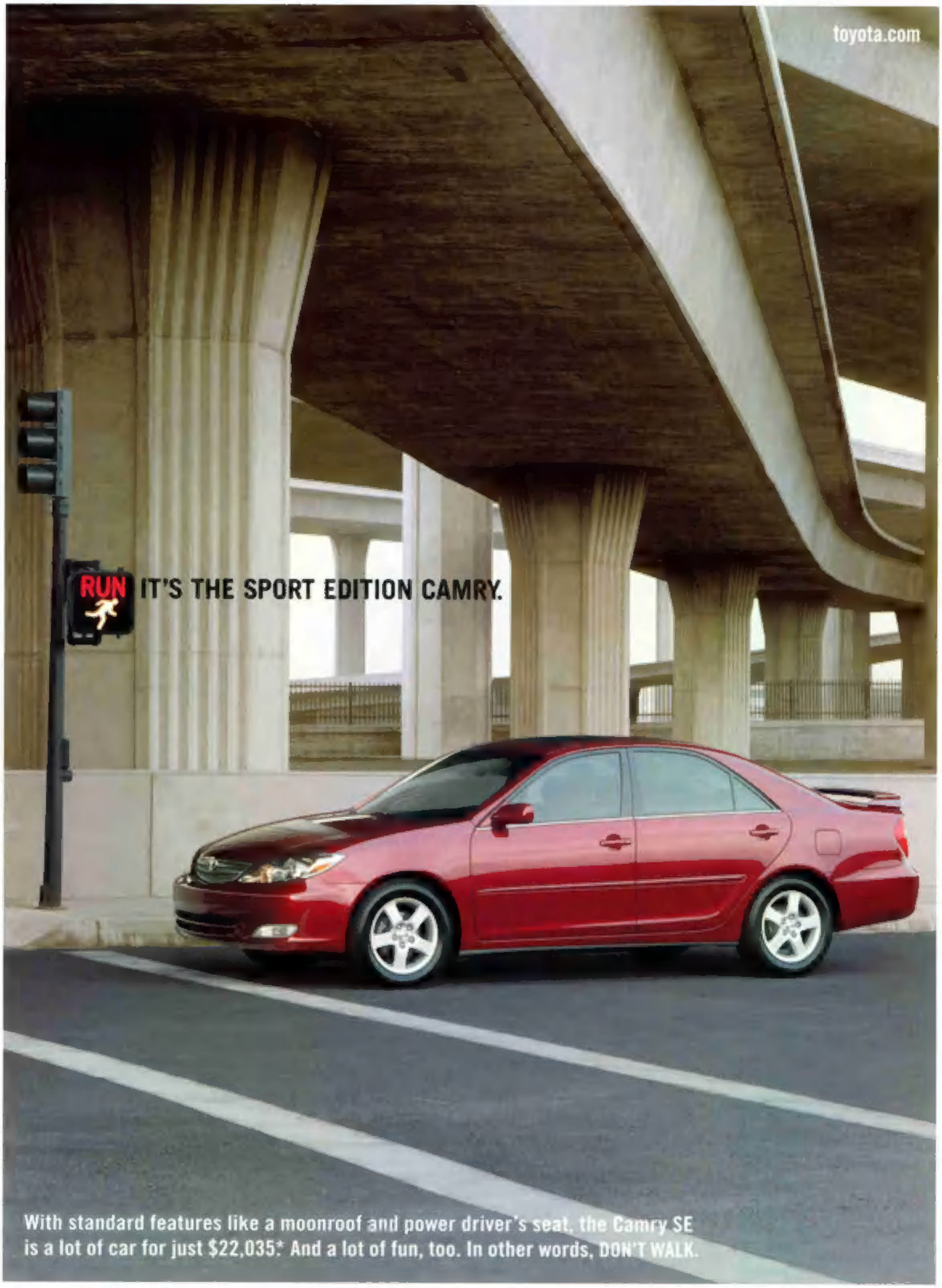

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